ENGINEERING

utlook
961

s issue :

terials Processing

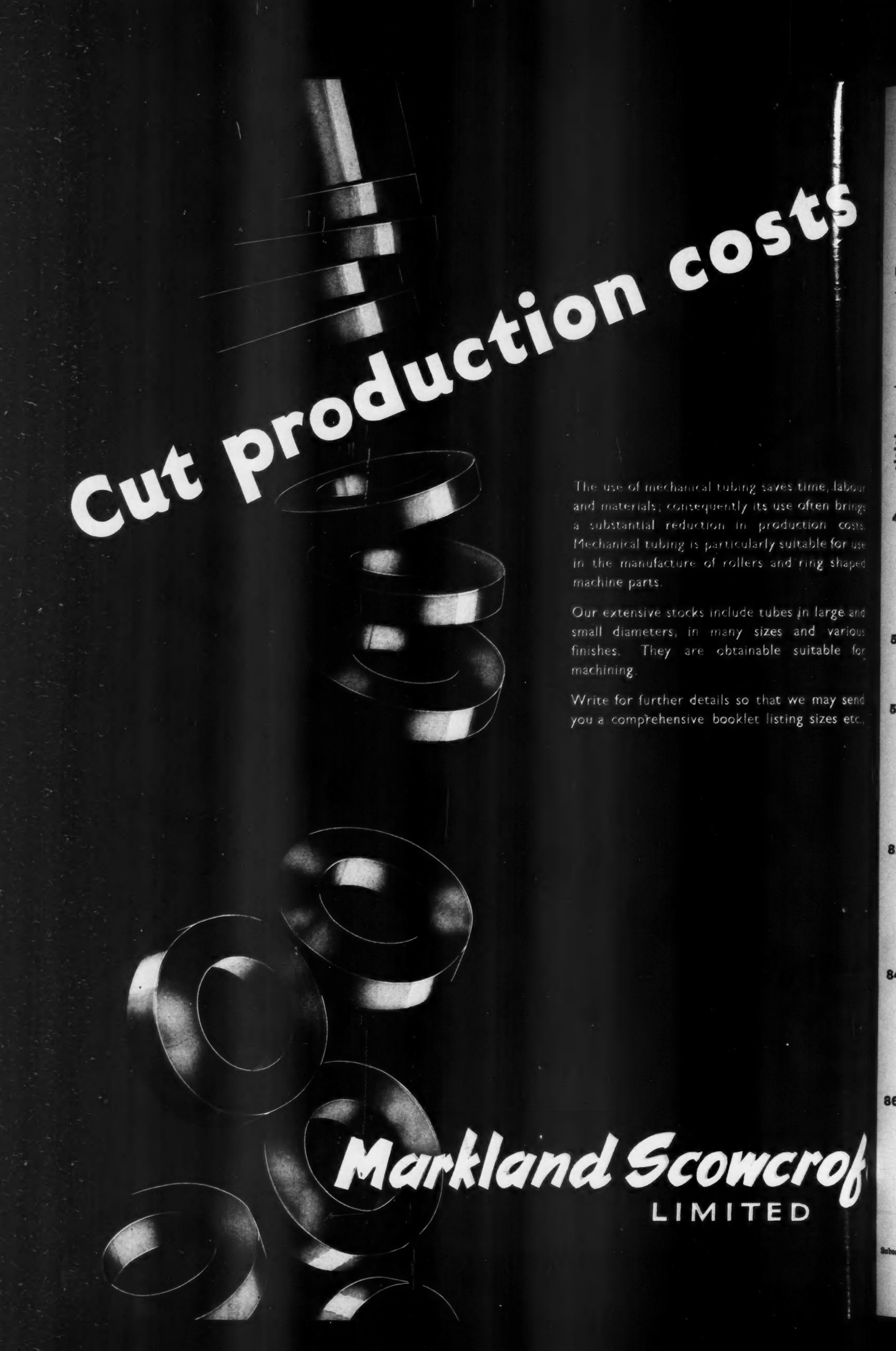
entific and
gineering
truments

il Engineering
d Building

THE UNIVERSITY OF MICHIGAN
ENGINEERING

E
/-

m Clock Assembly


Cut production costs
The use of mechanical tubing saves time, labour and materials; consequently its use often brings a substantial reduction in production costs. Mechanical tubing is particularly suitable for use in the manufacture of rollers and ring shaped machine parts.
Our extensive stocks include tubes in large and small diameters, in many sizes and various finishes. They are obtainable suitable for machining.
Write for further details so that we may send you a comprehensive booklet listing sizes etc.
Markland Scowcroft
LIMITED

13 January 1961

Vol. 191 No. 4943

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone: Temple Bar 3663

Contents

Outlook 1961

70 Materials Processing
74 Scientific and Engineering Instruments
78 Civil Engineering and Building

46 Metals and Materials

Castings—From Fracture to Strength

Plastic Faced Building Slabs, Corrugated and Troughed Aluminium Brochure, 83ft High Aluminium Mast, Colour Coding with Nylon Lubricators, Gelled Primers Protect Steelwork

50 Construction

Bridge Traffic Grows?—Sling a New Deck

Thames Estuary—Crossing by Supergrid

56 New Plant and Equipment

Spraying Machine, Oxide Resistors, Drier, Bench Press, Welding Shield, Electrode Holder, Involute Tester, Shaft Seal, Voltage Range Indicator, Profile Polisher, Stair Brackets, Packaged Dehumidifiers

Physical Exhibition
Voltmeter, Colour Meter, pH Electrode, Spectrophotometer, Ball Surface Tester, Water Monitor

82 Production

Electric Arc Melting on the Large Scale, Classifying Solids Held in a Liquid, Micro Leak Detection, BCAC Revived, Ultrasonics and Gold Plate, Improved Control for Bottle Making, Following the Motor Industry, Cleaner Conditions in Scotland

84 Research and Development

Engine Measurements by Radio Telemetry

Gauge for Ultra High Vacuum, New X-Ray Diffraction Laboratory, High Temperature Selenium Rectifiers, Extra-High Voltage Transmission, Improved Wear for Machine Parts

86 Design

Hermic Switch Prevents Circuit Accidents, Power Station Boilers Use Coal Oil or Refinery Sludge, Greater Loads in Less Space with Wedge-belt Drives, Oil Circuit Breaker Easily Transported, Soaker Flanges in Two Pieces, "Do it Yourself" Computer Components, Large Range of Draughtsmen's Templates, Air Cylinders with Square Ends, Lightweight Machine Access Doors, Fittings for Overhead Power Lines

45 Impact

53 Human Element

61 Companies

69 Marketing

62 Product Profile

The Cooke Troughton and Simms M15 Series Microscope

Special Article

54 Water Brings Backward Lands to Life
By A. N. M. Robertson

59 Atomic Review

Nuclear Superheating

65 Automobile Review

Panorama of Performance
By Brian Lister

88 At Home

Switches and Sockets

48 Plain Words

By Capricorn

48 Letters to the Editor

Precoated Steel Strip
John Hall

Parallel Surface Thrust Bearings
F. J. Wren

49 Events in Advance

66 Publications

On the Shelf
By Frank H. Smith

Chemical Analysis of Cast Iron and Foundry Materials
Physicochemical Measurements at High Temperatures
Reinforced Concrete Chimneys
Science in Space
Civil Engineering Handbook

New Books and Trade Publications

Cover Picture

Assembling the movement-stage, motion work, alarm mechanism and false plate in an alarm clock. (*Nurnberg photograph for* ENGINEERING)

Subscription Rates: Editorial page 88

Index to Advertisements: Overleaf

Engineering Appointments Section: Faces page 60

Advertisers in 'Engineering' this week

	PAGE
Adamson, J., & Co., Ltd.	36
Allen, A. H., & Co. (Engineers) Ltd.	34
Amal, Ltd.	18
Armstrong Patents Co., Ltd.	62
Ashmore, Benson, Pease & Co., Ltd. *Wrapper*	v
Associated Electrical Industries, Ltd. Transformer Division.	40
Atlas Copco AB. (Sweden) *Wrapper*	VI
AtlaaS teel Foundry & Eng'g. Co., Ltd.	34
Austin, E., & Sons (London) Ltd.	70
B.T.R. Industries, Ltd.	5
Barns, W., & Son (Holloway) Ltd.	8
Barry, Henry & Cook, Ltd.	29
Begg, Cousland & Co., Ltd.	32
Booth, Joseph, & Bros.	65
Bristol Siddeley Engines, Ltd.	37
British Aero Components Ltd. *Wrapper*	VIII
British Ermeto Corpn., Ltd.	5
British Iron & Steel Federation	26 & 27
British Steam Specialties Ltd.	70
Broom & Wade, Ltd.	22 & 23
Brown, David, Corpn. (Sales) Ltd.	54
Brown, Donald (Brownall) Ltd.	43
CIBA (A.R.L.) Ltd.	35
Carter, B. & F., & Co., Ltd.	30
Cawkell Research & Electronics, Ltd.	15
Centrax, Ltd.	2
Chesterfield Tube Co., Ltd.	66
Cleaver-Hume Press, Ltd.	4
Clyde Crane & Booth, Ltd.	65
Clyde Crane & Eng'g. Co.	65
Clyde Rubber Works Co., Ltd.	12
Cohen, G., Sons & Co., Ltd.	16
Colt Ventilation, Ltd.	25
Conveyor & Elevator Co. (1936) Ltd.	10
Crofts (Engineers), Ltd. *Wrapper*	IV
Dallow Lambert, Ltd.	61
Darlington Forge Ltd.	47
Davy-Ashmore Group. *Wrapper*	V
Dawe Instruments, Ltd.	31
Dobbie McInnes Ltd.	15
Dowty Rotol, Ltd.	19
Edwards, F. J., Ltd.	58
Eltron (London) Ltd.	58
Empire Rubber Co.	53
"Engineering" Calendar.	58
"Engineering" Reprints	29, 36
Engineering, Marine Welding and Nuclear Energy Exhibition, 1961	7
Expanded Metal Co., Ltd.	29
Fenner, J. H., & Co., Ltd.	71
Fenter, Ltd.	12
Firth Brown Tools, Ltd.	20
Flexible Ducting Ltd.	32
Frank, Charles Ltd.	65
General Electric Co. of England, Ltd.	59
Godfrey, Sir G., & Partners (Industrial) Ltd.	33
Grafton Cranes, Ltd.	30
Haddon, T. & Stokes Ltd.	6
Hall, J. & E., Ltd.	11
Hartleys (Stoke-on-Trent) Ltd.	65
Head Wrightson Processes Ltd.	45
Heenan & Froude, Ltd.	58
Herbert, A., Ltd.	8
Hilmor, Ltd.	15
Hockley Foundry Co., Ltd.	18
Hoffmann Mnfg. Co., Ltd.	18
Horseley Bridge & Thomas Piggott, Ltd.	12
Hudson & Wright, Ltd.	6
Ilford, Ltd.	55
Imperial Chemical Industries, Ltd. Metals Division.	57
International Computers & Tabulators Ltd	48
Jones & Lloyd, Ltd.	19
Lee, A., & Sons, Ltd.	42
Low, A., & Sons, Ltd.	49
Lysaght-De Vilbiss Division of J. Lysaght's Ltd. *Wrapper*	VII
McNeil C., Ltd.	69
Marconi Instruments, Ltd.	9
Markland Scowcroft, Ltd. *Wrapper*	II
Massey, B. & S., Ltd.	56
Mavor & Coulson, Ltd.	28
Micanite & Insulators Co., Ltd.	63
Mobil Oil Co., Ltd.	44
Newbury Diesel Co., Ltd.	58
Painut Co., Ltd.	36
Park Gate Iron & Steel Co., Ltd.	30
Parks Forge, Ltd.	10
Parsons, C. A., & Co., Ltd.	24
Power Auxiliaries, Ltd.	31
Priest Furnaces, Ltd.	12
Ratcliffe, F. S. (Rochdale) Ltd.	34
Reavell & Co., Ltd.	13
Regent Oil Co., Ltd.	41
Robertson, W. H. A., & Co., Ltd.	46
Robinson, L., & Co. (Gillingham) Ltd.	70
Robson, G., & Co. (Conveyors) Ltd.	65
Rose, Downs & Thompson, Ltd.	38
Rubber Bonders, Ltd.	53
Saunders-Roe, Ltd. (Electronics Division)	67
Scriven Machine Tools, Ltd.	58
Self-Changing Gears Ltd.	14
Sentinel (Shrewsbury) Ltd.	72
Serck, H. O., Ltd.	60
Smiths Industrial Instruments, Ltd.	64
Somers, Walter, Ltd.	51
South Durham Steel & Iron Co., Ltd.	52
Stanley, W. F., & Co., Ltd.	56
Steel Construction Co., Ltd.	17
Steels Engineering Installations Ltd.	21
Stream-line Filters, Ltd.	10
Sykes W. E. Ltd.	4
Taylor & Hubbard, Ltd.	32
Taylor Industrial Clutches	60
Tecalemit, Ltd.	50
Thermic Equipment & Eng'g. Co., Ltd.	63
Tonks, J., & Co., Ltd.	10
Vulcan Boiler & General Insurance Co., Ltd.	66
Wallsend Slipway & Eng'g. Co., Ltd.	68
Ward, Thos. W., Ltd.	
Weir, G. & J., Ltd. *Wrapper*	
Wellman Bibby Co., Ltd.	
Wellman Smith Owen Eng'g. Corpn., Ltd.	
Westwood, J., Co., Ltd.	
Whittaker, Hall & Co. (1929) Ltd.	
Winn, W. Martin, Ltd.	
Worcester Valve Co., Ltd.	
Zwicky, Ltd.	

'Engineering' Appointments Section inside Editorial Section

Birmingham Tame & Rea District Drainage Board.	4
Bristol Aircraft, Ltd.	1
British Cellophane, Ltd.	3
British Constructional Steelwork Association.	5
Centrax, Ltd.	2
English Electric Aviation, Ltd.	
Imperial Chemical Industries, Ltd.	3 & 4
Kodak, Ltd.	
Management Selection, Ltd.	2 & 3

Classified: Trade & Technical

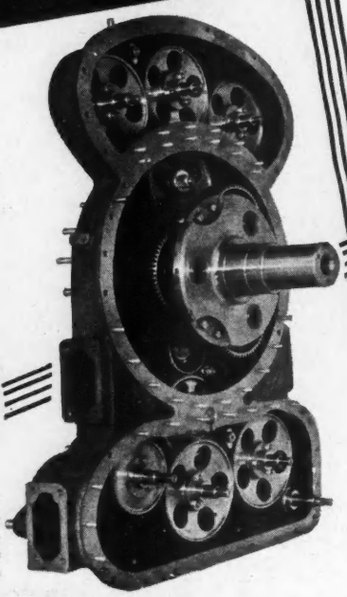
Bell, H. (Machine Tools) Ltd.	3
Burrill, F., & Co.	3
Edwards, F. J., Ltd.	3
Haseltine Lake & Co.	3
India Store Department.	3
London County Council	3
London, University of.	3
Monney, C. R.	4
N.A.T.O. Common Infrastructure	
Norris Bros., Ltd.	
Plint & Partners	
Pratchitt Bros., Ltd.	
Research Engineers, Ltd.	
Wallasey, County Borough of	

CENTRAX

—MANUFACTURERS OF PRECISION GEARING

...produced to your own specification, or designed by us to your requirements. Industries served include Automotive, Aircraft, Nuclear, Automation, Machine Tools, Earth Moving and General Engineering.

This divider gearbox is used on a snowplough. It has a single input shaft which transfers the drive to two output shafts through a gear train which gives high and low ratios with manual selection.



For use on an industrial gas turbine engine, this epicyclic gearbox reduces from 26,000 r.p.m. to an output speed of 3,000 r.p.m. in one step. There are nine auxiliary drives and a starter drive.

ACCURACY AND QUALITY ON A PRODUCTION BASIS

With acknowledgments to All Wheel Drive Ltd., Camberley, Surrey

Used in 3 versions on "Michigan" Tractor Shovels, this box has proved completely trouble-free under the most arduous conditions. It has 4 forward and 4 reverse gears with manual high-low range selection. 2 or 4-wheel drive.

CENTRAX

CENTRAX LIMITED, Newton Abbot, Devon.

Sales Office: 248-250 Tottenham Court Road, London, W.1. LANgham 2364/5

ENGINEERING Impact

of the Dilemma facing Steel in 1961

With output for consumer markets in decline, it has for some time been evident that part of the maintained demand for steel has been based on the high level of activity in the plant and machinery sections of the engineering industries and on the continued activity in construction.

Since the British steel industry is this year to lay out at least £150 million, raising its production capacity in crude steel to 27 million tons, it is pertinent to ask how the demand is going to make out.

It is the declared aim of every senior executive to obtain the maximum output from every item of capital expenditure. This implies the highest possible use of each ton of steel used in producing machine tools or any other industrial equipment. In the other direction, it is self-evident that equipment may be worn out more swiftly and is becoming uneconomic, in relation to newly-equipped competitors, much more rapidly. So for a steady rate of production there may be fewer machines required by the manufacturers, but they will need to replace them more frequently.

Modest Growth

Given that the rate of demand for cars, washing machines, electrical household appliances generally, is likely in future to bear a closer relation to the very modestly advancing growth in consumer demand, about 2½ per cent a year, there may be a doubt that all the extra steel that will become available will be taken up by production and capital investment in these sectors.

Britain's 1962 capacity for the output of steel is put by the British Iron and Steel Federation at more than 30 million tons. By investing another £450 million this is, on present plans, to be brought up to over 34 million tons a year. This will enable the steel firms to take care of what may be greater seasonal fluctuations in sections of industry. Within the general drive to increased capacity, at a rate faster than in the European steel industry, there is a great deal of attention being paid to cost reduction and so to export competitiveness.

Maintaining Exports

Last year's steel exports reached the record level of 4·2 million tons. Worth some £230 million, this more than equalled the cost of all the steel industry's raw material imports. The British Iron and Steel Federation expects that despite increasing overseas competition, this export level will be kept up.

For the general outlook of steel consumption on the world scale, it is worth recalling that intensive efforts are being made in many African and Asian states to lift the standard of living and industrial activity to the economists' "take-off" point, where consumer demand and investment within the particular economy begin to generate increasing production and consumption.

As this comes about over wider areas the opportunities for cost-competitive manufacturers, and for basic suppliers like the steel industry, could be such as to keep the level of activity of the United Kingdom iron and steel interests in the mid-1960s very high indeed.

OEEC Recommends More UK Investment and Export

Echoes of the views of the British Government and of United Kingdom employers are clearly apparent in the survey of economic conditions in 1960 by the Organisation for European Economic Cooperation. It is this survey in which OEEC expresses its disappointment that a smoother and more rapid rate of expansion has not been maintained in Britain.

The solution recommended by the survey is that the ratio of exports to total production be raised to a permanently higher level in order to avoid having to restrict the growth of the economy below the rate at which it is capable of advancing.

OEEC approves of the setting up of an export council for Europe and also believes that much more lively sales efforts should be made in the Commonwealth, where non-sterling competition is now extremely intense. Another echo of a well worn theme is the statement that small and moderate sized firms should go into the export business and that they should make better use of officially provided promotion services.

Unbiased Warning

It ought to be possible for the more far seeing trade unionists—free in this case from the suspicion that they are being given a partisan argument—to consider the OEEC warning on the point that if wage demands go ahead at full steam, production costs in the UK will be given a fresh push upwards at a time of increasing competition when it is more and more difficult to pass the effects on to the customer.

Some of the OEEC criticisms are already being met. For Britain to raise its production to match the performance of other European states, the survey suggests that investment of more of the national income is required, that technical education must be developed further and that labour-saving techniques must be utilised more.

Some Improvement

The high level of activity in the capital goods manufacturing firms is only one indication that the level of investment is in the ascendant. As yet it is only a White Paper, though backed up by much preparatory work, but the Government's *Better Opportunities in Technical Education* points the way to better instruction of Britain's skilled labour force. In labour-saving techniques, while there are some firms who have not yet thought that this concerns them, there are others, from the metal forming industries right through to agriculture, where productivity has been increased many hundred per cent.

For the immediate future, OEEC tends to believe there may be some improvement in the general prospect though in an uncertain world trade market it does not expect any remarkable increase in exports.

of Major Advance in Submarine Pipelines

High among the engineering contributions to the prosecution of the Second World War was PLUTO, the flexible under Channel pipeline which carried fuel to the Normandy beachhead, providing an answer to the extremely difficult problem of meeting the enormous demands of transport.

Associated with the Pluto development were British Insulated Callender's Cables, who are now to produce and instal the 53 miles of flexible submarine cable which will carry natural gas from the Canadian mainland of British Columbia to Vancouver Island. The authorisation given to the Magna Pipeline Company of Vancouver Island, who have placed the contract, worth $7 million, with BICC, specified the use of flexible pipeline.

BICC have earned for themselves not only a valuable contract but have achieved for flexible submarine pipelines what in effect will be something of a standing showpiece—a working example, from its laying in 1963—which will be of special importance in considering future major underwater pipeline projects.

Plainly where long distances of submarine pipeline are to be laid the advantages of uncoiling four mile sections from the hold of a ship are very great. With a bore of 4·8 in the BICC flexible pipeline is able to transmit about 50,000,000 cu. ft of natural gas in 24 hours. It is appropriate to use cable terms for the pipeline, which will in fact be made on cable producing equipment at Trafford Park, Manchester. The 24 hour capacity in natural gas is the equivalent of 750,000 hp or 560 MW, which is about the output of Battersea power station.

One of the largest water barriers between power reserves and industrial capacity is the Mediterranean, separating the natural gas reserves of the Sahara from the industries of the European Common Market and also of Britain. Here is an opportunity for submarine pipeline on the grand scale. This is not news to BICC, they have been in contact with the engineers studying the special crossing problems for the Saharan oil companies.

Whether in linking islands to mainlands (the Isle of Wight?) or in carrying the resources of one continent to another, flexible submarine pipeline has been shown to have as important a role for future industrial development as its forerunner from the coasts of Britain played in purely military terms.

Twentyfour-hour Day for Tank Warfare

Weapon developments are only occasionally of technical significance for more general application but every so often there occurs a step forward in military equipment which is so far reaching as to be interesting for its own sake.

One of these is the development of the application of a new type of searchlight to the United States M60 tank which will make it possible for tanks to fire accurately at night. The heart of the new device is the xenon lamp which projects either infra-red rays or a beam of visible light. Using infra-red at night the tank will not give away its position so obviously as has been inevitable with conventional tank searchlights.

The xenon lamp can also transmit light beams with an intensity of 95 million candlepower in a narrow beam for the last adjustments of final gunlaying. When the infra-red system is in use the periscopes of the tank gunner and the commander will convert the rays to visible light. The commander is also to be equipped with binoculars enabling him to see the infra-red illumination by the xenon searchlight and that produced by the infra-red headlights of the tank.

Since close cooperation exists between Britain and the United States in armoured weapon developments (the American M60 carries the new British 105 mm gun) it is thought that the Chieftain, the new UK battle tank now under development, may be fitted with the infra-red direct control system.

Tank fights at night in the Second World War were fought by anything from moonlight to the flames from the casualties. The evident difficulties tended to cancel out because neither side could see what the other was up to, though an attack, since it was hoping to go to some kind of plan, was sometimes less likely to fall into chaos.

Division for division the conventional forces of the West, and particularly NATO, will be significantly strengthened by giving their armour round-the-clock performance. It may even help forward the disarmament talks.

and the Small Boat is Big Business

Small boats have been made on British rivers and around the coast for centuries, but only in the last few years has the business of small boats become the concern of hundreds of firms and tens of thousands of people who put some form of yachting or cruising as their first leisure activity.

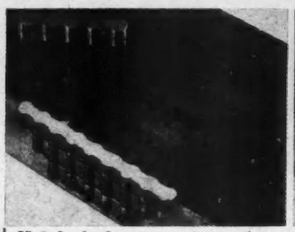
The International Boat Show which has just closed at Olympia, in West London, has shown how the biggest concerns in the United Kingdom—firms like Hawker Siddeley, Perkins and the Dowty Group—and the smallest, almost one-man affairs, are involved. They are drawing on the newest developments in materials and in engines to advance the design of small boats, and by reducing the cost, enlarging the number of people who can afford to hoist their own flags.

Freshly blooming prosperity among the small boat makers has helped to cushion at least one branch of industry from the effects of rapidly changing markets. On the farms the number of independent diesel engines has naturally declined as developments in power take-off equipped tractors and Landrovers have given farmers the double advantage of a usable tractor or truck that is also a mobile power unit. But much of the new construction in small boats is of motor cruisers, and the sailing enthusiast needs auxiliary power, too, so useful demand for diesel engines has sprung up there.

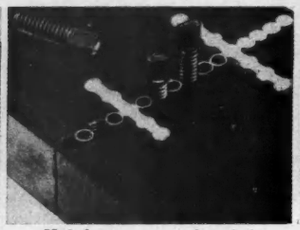
There is a complication in all this. In a time of the almost universal five-day week, and with more or less general affluence, the number of those who can head out into a popular area like the Solent grows and grows. On some waters the total of those seeking escape from the world of traffic jams, parking meters, noise and bustle is so great that it is only a matter of time before strict controls are added to the other risks.

Castings—From Fracture to Strength

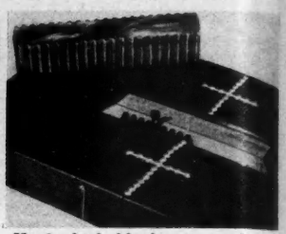
For those who haven't yet met it, here is Metalock's system of mending fractured iron and steel castings. For those who have, here are a few highlights and an appraisal of the last fifteen years.



***Metalock keys** are inserted in channels at right angles to the fracture. They undergo individual peening before the one immediately above is inserted.*



***Metalaces** are threaded inserts used along the line of fracture. When screwed into position they form a liquid and gas tight seal.*



***Masterlock blocks** are made in high tensile steel. More stress can be transmitted through them than could be carried by multiple Metalock keys placed in the same area.*

IN THE autumn of 1960, the chief engineer of Metalock (Britain) Ltd. gave a lecture on his company's method of repairing fractured castings. Since their process has been practised for fifteen years, it could be asked why on earth he was asked to do this when everything must already have been said. But, of course, no materials have yet come to make the iron and steel casting obsolete, and so long as humans are human—which means occasionally trying to put a quart into a pint pot—there will be fractures and a need for a repair service of this sort. In this job, no two repairs are identical, so this means new experiences the whole time. In that lecture, Metalock's self-appraisal was pretty realistic, so from now on the words are those of their chief engineer.

Craftsmen, especially the older ones, will immediately recognise the affinity of the Metalock Key with the old fashioned and well tried "link" or "blacksmith's dumbell." The efficiency of the latter relied upon close machining and near shrinkage tolerances, whereas Metalock keys, being of ductile nickel-steel, can be peened into a metal and become almost integral with the parent metal of the object under repair.

The Metalock repair has been used primarily on iron castings but with the growth of experience many steel castings are now being restored. Less frequently, fabricated steel units, which for reasons of distortion cannot be subjected to the heat required for welding, have been repaired with complete success. Virtually any casting ¼ in thick or over can be repaired.

Hydraulic pressures of up to 7,000 lb per sq. in and steam pressures of 500 lb per sq. in have been successfully contained. Temperature limitation is 1,500° F except in such cases as gas retort castings, slag ladles and ingot moulds, where extreme breathing of the repair is not disadvantageous.

When a casting has been badly shattered, the resulting pieces are sometimes very small and the Metalock repair is not applicable. This problem can be overcome in most larger castings by cleaning up the jagged edges of the breakage and locking into position a new portion of fitted casting. Such repairs have been and are being carried out extensively on engine bedplates and entablatures after a loose bottom end has run amok.

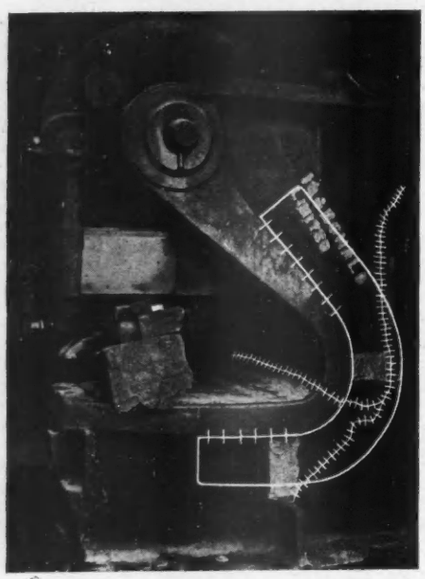
Fractures which run in sharp fillets or on corners are also an enemy of the Metalock man, but again on numerous occasions the technique of cutting away the offending section and replacing it by a new piece has saved the day.

Approximately one-fifth of the breakdowns seen by the company's surveyors are abortive as a Metalock repair. This cautious attitude is well appreciated by engineers who prefer a frank "no" to the alternative of a dubious repair.

Because of it's cautious application, the Metalock process suffers few failures. On over 15,000 guaranteed jobs, cheques in refund of the repair fees have only had to be written out on six occasions. That is not to say that there have not been a number of other failures, but in most instances these have only been partial and have been made good.

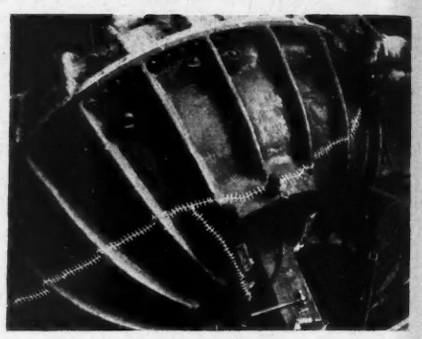
Failure of a repair can rarely be traced to a bad Metalock design but mostly to abusive or abnormal working conditions. The causes can all too often be traced to the over quick warming through or cooling down of a steam or thermal unit, the overloading of a press or guillotine, or the careless use of a machine tool. It is amazing how such abuses are duplicated on the same machine and it follows that the overload breakage occurs roughly in the same position even after repair.

Bad original design of castings is a major reason for failures. An example can be given by quoting a diesel head in which awkward pockets have been cast in the cooling chamber; these lead to silting up with the resulting "hot spot" and subsequent cracking. Another example is the heavy shearing machine in a scrap yard which is worked by unskilled labour, who will always have a go at cutting high speed steel and if, as is often the case, the overload mechanisms is not delicate enough, the result is obvious. All too often there is a tendency, especially by unskilled labour, to have the mental approach of "well it's a big machine, it will take it"—without realising just how delicate such machines can be when approaching a full working capacity.

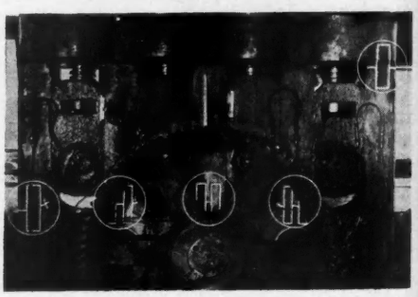


***Extra metal ensures full design strength.**—Sometimes it pays to add extra metal to make the repair even stronger than the original. Machine bodies with throats such as this shear are all the better for reinforcement once they have fractured. In this instance it would be made from 3 in ships' plate and fixed with Metalock keys.*

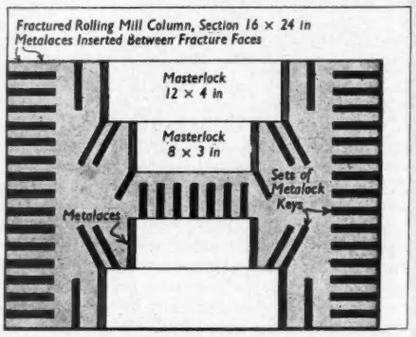
***Repairing large sections.**—The greatest depth to which channels for Metalock keys can be made accurately is 3½ in, but this does not limit the size of sections. Recesses are cut away to take multiple Masterlock blocks, as in this cogging mill column for Samuel Fox which had a section of 16 by 24 in. With this particular key and block pattern, the safe working stress is 380 tons—which is what it was designed for.*



***Webs present no difficulty.**—Reinforcing webs, as on this 12½ ton casing of a rotary strainer at Bromborough power station, present no difficulty. In this instance, they were of such a size that Metalock keys and Metalaces could be inserted along the whole 29 ft of fracture from the outer surface. Satisfactory clamping of the fractured parts was obtained by bolting the four sections of the cover together again.*



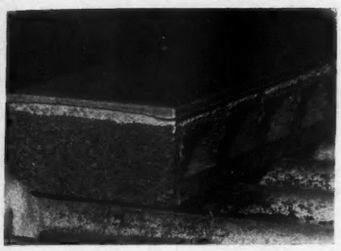
***Repair survives second fracture.**—This is the side view of a roll straightener for steel plate up to 1⅞ in thick. When first overloaded with 2½ in thick plate, the five columns on this side fractured and were mended with keys and blocks. After a further 3 years of satisfactory running it was again overloaded, but the fractures occurred on the opposite side. This speaks well for the company's claim that 90 to 95 per cent of full strength is normally obtained.*


Fractured Rolling Mill Column, Section 16 × 24 in
Metalaces Inserted Between Fracture Faces
Masterlock 12 × 4 in
Masterlock 8 × 3 in
Sets of Metalock Keys
Metalaces

Plastic Faced Building Slabs

A new principle in concrete building blocks for internal structural walls was demonstrated recently. Lord Granville, chairman of the Lilleshall Company, opened a new plant to produce what will be called Spectra Glaze concrete blocks, by a method developed by the Burns and Russell Company of Baltimore, Maryland, USA. A second plant, located in the north, is currently being planned by the Lilleshall Company.

The coloured glaze, applied to standard concrete blocks, consists of a thermosetting plastic binder with selected glass, silica sand, pigments and granules to supply colour. Cast on to each block, to a uniform thickness of $\frac{1}{8}$ in by a method which is said to ensure uniform dimensions, the glaze runs deep into the pores of the concrete, thus becoming an integral part of it. Blocks are



glazed either on one side, both sides, or a side and an end as needed.

Confidence in these blocks is also held by Cubitts who are holders of parallel patents for production of such blocks. The position is that Burns and Russell hold patents for applying a mix of polyester resins with minerals on to cementitious blocks by a moulding technique, while Cubitts hold similar patents using resins containing epoxies. Epoxies are at least twice the cost of polyester resins, but Cubitts say they have greater adhesion and do not need mechanical keying. In weathering resistance, it seems that the building trade has been pleasantly surprised at the performance of both families of resins, and some blocks based on polyesters have been giving satisfactory service for 15 years in the USA.

Spectra Glaze blocks are currently being produced in a standard range of 18 colours, with 40 special colours available to order. All can be used internally, and some colours are recommended for external use.

Lilleshall Company Limited, St. George's, Oakengate, Shropshire.

Corrugated and Troughed Aluminium Brochure

Aluminium Development Association have published their applications brochure number 14, entitled *Aluminium Corrugated and Troughed Sheeting* (price 10*s* 6*d*). This 56 page book describes aluminium corrugated and troughed roofing sheets by reference to the appropriate British Standards for this form of material.

The book opens with a brief statement of the advantages of aluminium in this field and then establishes clearly the various profiles before describing the weight, strength, thermal and other characteristics of the material for this purpose. There is a brief section dealing with components and accessories, and the choice of section properties and maximum recommended loadings. Though the book does not purport to be a textbook on design, say ADA, the essential points concerning design loading are established together with other considerations such as roof pitch and laps. The concluding sections of the book deal with installation practice and, very briefly, with the few points on site handling and storing that are of importance for aluminium.

Probably of greatest interest to the architect and engineer will be the set of drawings which give general details, fixing and laying details and arrangements.

Aluminium Development Association, 33 Grosvenor Street, London, W1.

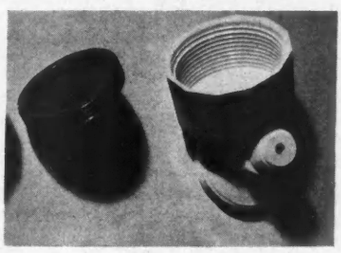
83 ft High Aluminium Mast

The 43 ton yawl Manita, launched last November at Port Hamble, will be carrying one of the largest aluminium masts ever extruded in this country. With an overall length of 83 ft, the mainmast consists of five sections of flat-sided oval tube, supplied by the British Aluminium Company. Each section has been sleeved into the next, rivetted internally, and finally flush welded to give a smooth external finish. In last year's Olympics in the Bay of Naples, 13 competitors carried aluminium masts.

British Aluminium Company Limited, St. James's Square, London, SW1.

Colour Coding with Nylon Lubricators

This seems a very simple but sensible idea: Trendon Limited are now making Stauffer screw pressure lubricators in nylon. They come in a range of five colours, and since the pigment is incorporated in the plastic the colours should be permanent. This means that grease points will



stand out against machinery, and colour coding for maintenance schemes is made easy.

With a diameter of $1\frac{1}{2}$ in and a capacity of $\frac{1}{2}$ fluid oz, the lubricators have a standard nipple connection of either $\frac{1}{4}$ or $\frac{1}{8}$ BSP.

Trendon Limited, Malton, Yorkshire.

Gelled Primers

Savings in time and labour costs of protecting structural steelwork from corrosion can be effected by a new painting system developed by John S. Craig and Company. Thick film gelled primers, two coats of which are equal to four or five coats of conventional paints but which do not sag or "curtain" after application, were introduced by the Craig Company at the Scottish Industries Exhibition in September, 1959, after extensive laboratory and raft exposure tests.

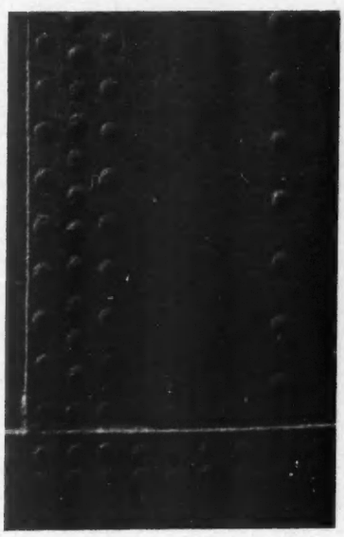
At that time the products were primarily developed for the marine market, where corrosion is an ever present problem, and where there is often an additional problem in providing adequate protection to steelwork because of a ship's limited time in dry dock.

Laboratory work performed by the Craig Company had produced a range of gelled primers based on red lead, calcium plumbate, zinc chromate and basic lead sulphate. Red lead and calcium plumbate primers were intended for use on structural steelwork or ship's superstructures, the zinc chromate paint for general use on steel or aluminium, and the basic lead sulphate primers for general purpose use on steel exposed to water, but particularly on the topside and underwater areas on ships.

Of these primers, the red lead and calcium plumbate ones tended to harden rather slowly in such thick films (which may limit their use to those circumstances where speed of drying is not imperative). The underwater basic lead sulphate type primers, however, could be made to dry quickly even in thick films and their use in ship repair work and heavy industrial maintenance was investigated.

Major ship trials were initiated in 1959. MV Elysia, of the Anchor Line, was extensively scaled in drydock in September, 1959. Scaled plates on the port side were painted by the established process, comprising three coats of conventional liquid bare plate primer (Impervo protective) followed by the usual anti-corrosive and anti-fouling compositions. Weather conditions during these tests were good, warm dry days with cool dry nights. Since repair work on the ship allowed adequate time for painting, overnight intervals were allowed between coats on most plates, though it had been shown that two coats could be applied evenly wet on wet within 30 minutes of each other when the coats were of different colours. The system used was: (1) one thin coat Impervo wash primer, about 1,000 sq. ft per gallon; (2) one intermediate coat Ferrogel A (one of the new primers) at 150 to 200 sq. ft per gallon; (3) one intermediate coat Ferrogel B at 150 to 200 sq. ft per gallon; (4) one coat Craigs anti-corrosive composition; and (5) one coat Craigs anti-fouling composition.

The above ship undocked on 3 October, 1959, and made regular voyage from the United Kingdom to Bombay. She dry docked again on 1 September, 1960. The general condition of both standard Impervo protective on the port side and Ferrogel on the starboard side was excellent. The illustration shows the condition



of a Ferrogel protected area.

As many industrial structures are subjected to severe anti-corrosive conditions, but are inaccessible except during process shut-down, the ability to apply very heavy coats of primer in short time is obviously attractive, especially where high staging must be erected before painting. Accordingly, several high steel supporting structures for tanks and water coolers at Colvilles' Dalzell works were coated with the gelled primers during the works shut-down in July, 1960. Application properties were found to be satisfactory allowing recoating either wet on wet, or at 24 hour intervals.

Inspections to date show that durability is excellent, even in the most severely exposed conditions (continuous cascades of hot water, or water mist combined with sulphur containing smokes from adjacent furnace stacks). The advantages in cost, time and convenience of application have been demonstrated, but the Craig Company will not issue their detailed assessment of performance on this latter application until the primers have been on trial for a full twelve months.

John S. Craig and Company Limited, Shieldhall, Glasgow.

Plain Words

By Capricorn

Pity the poor planner. Last week I was mocking him for his thoughtless enthusiasm. This week I am repentant. We scoff at his predictions; we curse him for interfering with our lives. But we depend on him.

Picture him in his office, puzzling over the formless future, giving it shape, conjuring coordinates from a meaningless continuum, adding definition to the void. On the blank sheet of tomorrow he rules a centre line—if only as a datum to be departed from. He is a lonely figure, living in a dimension different from our own; and, like Cassandra, unbelieved, unhonoured in his own establishment.

He examines the situation carefully, bearing in mind a thousand possibilities, foreseeing the threat of Common Markets, consumer disenchantment, economic downturns, credit squeezes, technical breakthroughs by rival manufacturers, and shortages of raw materials. Conscious of these hazards, he presents a series of proposals to his management, who, normally quite reasonable men, now become abysmally obtuse. They attack his conclusions, but fail to grasp his arguments; and disregard his warnings, as if the habit of public optimism had overlaid their caution. After passing from office to office, his recommendations are returned, scarred with deletions, scattered with marginal interrogation marks, and altered beyond recognition.

Planning should not be rejected because planners are occasionally inept. It would be surprising if planners did not sometimes make mistakes; no one has full details of the future. But it would be a dismal fellow who refused to book accommodation for his family's summer holiday because he could not guarantee fine weather.

Planning depends on forecasting to different degrees. A programme may be fitted to a pattern of events or based on the assumption that events cannot affect it. Thus a civil engineer engaged on a three-year construction project will plan his building schedule on the basis of his past experience, forcing the future into a framework of his own design. Whereas an instrument manufacturer, being almost invariably a subcontractor, watches events, the national industrial programme, projects proposed by other companies, and forms his plans accordingly. Even more subject to the changing situation is the materials producer.

The planner has to be flexible yet definite. And no one ever gives him all the necessary data. He isn't even told his terms of reference. A recent correspondent to *The Times* has suggested that present time scales are too short, and proposes five-year plans instead of annual budgets. How can the planner plan in such a context?

I must confess that next week's rise in London fares is going to upset my New Year's budget.

Letters to the Editor

Parallel Surface Thrust Bearings

Sir, May I point out that Dr. A. Cameron's theory for the performance of parallel surface thrust bearings is not as new as is implied by the title of his article (Engng., 30 Dec. '60, p. 904)?

His list of references should include H. W. Swift, *Proc. Inst. Mech. Engrs.*, vol. 155, 1946, p. 57, where he will find an earlier presentation of this theory.

Yours faithfully,
F. J. Wren.

New Dunston, Northampton.
6 January, 1961.

Precoated Steel Strip

Sir, As the pioneers in this country of the production of precoated steel sheet, and the makers of the major portion of it now manufactured here, we cannot allow the article entitled "What's Been Happening in Precoated Strip" (Engng., 30 Dec. '60, p. 878) to go unchallenged.

The writer recalls that, in an article in March, the opinion was stated that "pvc-coated products were really 'teasers' in that they needed considerable thought on how best to use and fabricate them." He admits that this view was contested "by a firm"—it was ourselves—but continues, however, "it does seem to be borne out by comments of other people who offer these materials."

By implication that is a reflection on Stelvetite, our pvc-steel laminate, but it is nowhere supported by facts.

One would be interested to know who the people are who made these comments, and what they said. Until the writer is prepared to enlighten us we can only confine ourselves to facts—the experience of our many and increasing customers who use Stelvetite. None have complained to us of "teasers" in its use and fabrication. We would not claim that every problem has been solved but, in the main, our customers have found that Stelvetite can be formed and used in a similar manner to ordinary sheet steel. They are using it increasingly for the interior and exterior panelling of buildings, for the manufacture of gas and oil-fired boilers, furniture, kitchen and other domestic equipment, shopfittings, Post Office equipment, clocks, partitioning, drums and other articles. A somewhat astonishing list of uses for a material beset with teasers!

The writer deals with the question of weatherability and says John Summers "can quote that the LCC approved the use of their material in a block of flats in Stepney, but it is not yet clear what can be read into this." It does not seem to impose an undue strain on normal intelligence to read into it that highly-qualified architects, fully conscious of their responsibility, were sufficiently satisfied with Stelvetite's weather-resistance to incorporate it in the flats. And, incidentally, the people constructing Zidpark, the City of London's new multi-storeyed car park, are also clothing the structure with Stelvetite G. They are similarly satisfied. These are facts, not opinions, and maybe they will do something to eradicate the writer of the article's cynicism.

One final point. He states we have introduced Stelvetite G, "based on their electrogalvanised Galvatite." As Engineering circulates among people much concerned with accuracy, you, sir, I am sure, are concerned to make it a model of accuracy and, for that reason, we would point out that Galvatite is continuously hot-dip galvanised steel sheet or coil, and not electrogalvanised. Our electro-plated (we normally use this term and not electrogalvanised) product is Zintec.

Yours faithfully,
John Hall,
Public Relations and Advertising.
John Summers and Sons Limited,
London, SW1.
2 January, 1961.

Events in Advance

Man, His Work and Working Environment

Preliminary arrangements have now been completed by the provisional committee of the International Ergonomics Association for the holding of their first international congress on the subject, which will take place in Stockholm during the four-day period from 20 to 23 August, 1961. The general theme of the meeting will be "The Adjustment of Work and Working Environment to Man."

The programme has been planned to meet the needs of specialists in the different sections of the ergonomics field and will be based upon three main considerations: ergonomics in relation to the speed of work; the adjustment of work and working conditions to an ageing population; and ergonomical analysis of jobs (the evaluation of work and working environment from the ergonomical point of view).

It is intended that papers on the speed of work shall cover problems either in relation to machines; to earning systems; or to physiological aspects; or, perhaps, to a combination of these considerations. Papers on the second section, on the difficulties confronting an ageing population, will deal with the physiological and medical aspects, psychological aspects, and practical requirements. Introductory papers are accordingly being invited from selected authors on all these divisions of the general theme and the organisers are anxious to receive further papers from those engaged in the different branches of ergonomics.

Papers may be presented in English, French or German, and should be accompanied by summaries. Where a paper is submitted in French or German, there should be a summary in English as well as in the language of the paper. Original contributions rather than reviews of material already published will be given priority. The time to be allotted to the reading of each paper will be limited to 15 minutes, including, where required, the exhibition of slides. Abstracts are required by 1 March and the manuscripts of full papers by 1 July.

The congress is to be followed by a series of visits to professional and industrial organisations in Stockholm and other parts of Sweden. Correspondence may be addressed to Professor Sven Forssman, Svenska Arbetsgivareföreningen, Post Box 16120, Stockholm 16, Sweden. The United Kingdom representative on the provisional committee is Mr. Ronald G. Stansfield, 213 Fairview Road, Stevenage, Herts.

Exhibitions and Conferences

British Institute of Radiology: Annual Congress and Scientific Exhibition.—Wed., 26 April, to Fri., 28 April, at Church House, Great Smith Street, London, SW1, and Central Hall, Westminster, London, SW1. Offices of the Institute, 32 Welbeck Street, London, W1. Tel. WELbeck 6237.

National Art Materials Trade Association, 11th Annual Convention and Exhibition.—Thurs., 27 April, to Mon., 1 May, 1961, at Biltmore Hotel, Los Angeles. Association's offices: 30 N. Michigan Avenue, Chicago 1, Illinois, USA.

Graz International Spring Fair.—Sat., 29 April, to Sun., 7 May, 1961, at Graz, Austria. In the United Kingdom, applications should be made to the Office of the Austrian Foreign Trade Representa-

tive, 1 Hyde Park Gate, London, SW7. Tel. KNIghtsbridge 6938.

Agricultural Fair, 28th International.—Sat., 29 April, to Mon., 8 May, 1961, at Novi Sad. Organised by Novosadski Sajam, 11 Hajduk Veljokova, Novi Sad, Yugoslavia.

German Industries Fair.—Sun., 30 April, to Tues., 9 May, 1961, in Hanover. Agents in the United Kingdom: Schenkers Ltd., Royal London House, 13 Finsbury Square, London EC3. Tel. METropolitan 9711.

Brussels International Industries Fair, 34th.—Sun., 30 April, to Thurs., 11 May, 1961, at Brussels. In the United Kingdom, applications should be made to Belgian Railways, 167 Regent Street, London, W1. Tel. REGent 1491.

Valencia International Samples Fair.—Mon., 1 May, to Sat., 20 May, in Valencia. Apply to Feria Muestrario Internacional de Valencia, Llano del Real 2, Valencia.

Detection and Use of Tritium in the Physical and Biological Sciences, Symposium.—Wed., 3 May, to Wed., 10 May. Apply to the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria. (*The location of this event has not yet been decided.*)

Meetings and Papers

British Institution of Radio Engineers

LONDON
"A Fast Electronically-Scanned Receiving System," by Dr. D. E. N. Davies. Radar Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 1 Feb., 5.30 p.m.*
MANCHESTER
"Manufacture of Television Tubes," by P. Funnell. North Western Section. Reynolds Hall, College of Technology, Manchester. Thurs., 2 Feb., 7 p.m.

Chemical Society

DURHAM
"Development of Modern Gas Kinetics," by Professor A. F. Trotman-Dickenson. Durham Branch. Science Laboratories, The University, Durham. Mon., 30 Jan., 5 p.m.
EDINBURGH
"Some Hydrocarbon Complexes of Transition Metals," by Professor P. L. Pauson. Edinburgh Branch. Joint Meeting with the University Chemical Society. Biochemistry Lecture Theatre, New Buildings, The University, Teviot Place, Edinburgh. Tues., 31 Jan., 7.30 p.m.

Combustion Engineering Association

BIRMINGHAM
"Efficient Use of Gas in Industry": discussion to be opened by A. C. Jennings. Midland Region. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Wed., 25 Jan., 10.30 a.m.

Illuminating Engineering Society

BIRMINGHAM
"Visual Perception," by R. G. Hopkinson. Birmingham Centre. Regent House, St. Phillip's Place, Colmore Row, Birmingham. Mon., 30 Jan., 6 p.m.
EDINBURGH
"Lighting in Industry in the Soviet Union," by E. H. Norgrove. Edinburgh Centre. YMCA, 14 South St. Andrew Street, Edinburgh. Wed., 1 Feb., 6.15 p.m.
GLASGOW
"Office Lighting," by L. H. Hubble. Glasgow Centre. British Lighting Council, 29 St. Vincent Place, Glasgow, C1. Thurs., 2 Feb., 6.30 p.m.
NEWCASTLE UPON TYNE
"Hospital Lighting," by G. R. N. Chalmers. Newcastle upon Tyne Centre. The Percy Building, King's College, Queen Victoria Road, Newcastle upon Tyne 1. Wed., 1 Feb., 6.15 p.m.

Institute of Marine Engineers

BARROW-IN-FURNESS
"Oil Fuel Burning," by A. H. Skinner. Joint Meeting with the Barrow Association of Engineers. Merseyside and North Western Section. Central College of Further Education, Barrow-in-Furness. Fri., 27 Jan., 7.30 p.m.
NEWCASTLE UPON TYNE
"The Future Doxford Marine Oil Engine," by P. Jackson. North East Coast Section. Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne. Thurs., 26 Jan., 6.15 p.m.

Institute of Metals

LONDON
"The Development of Some New Bearing Materials," by P. G. Forrester. London Local Section. Thurs., 2 Feb., 6.30 p.m.*

Institute of Petroleum

LONDON
Radiation Resistant Greases: A Study of Thickeners and Antirads," by W. Crawford and Dr. D. B. Dox. Wed., 1 Feb., 5.30 p.m.*

Institute of Refrigeration

LONDON
"A New Conception in Cooling Tower Design," by Carl Munters and Lennart Lindqvist. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 2 Feb., 5.30 p.m.*

Institute of Road Transport Engineers

BATH
"A Review for the Selection, Specification and Design of a Commercial Vehicle," by E. B. H. Elsbury. Western Centre. Angel Hotel, Bath. Wed., 1 Feb., 7 p.m.
EDINBURGH
"Servicing in the Field": discussion. Scottish Centre. North British Hotel, Edinburgh. Mon., 30 Jan., 7.30 p.m.

Institution of Civil Engineers

LONDON
"An Approach to the Design of Tall Steel Buildings," by Jacques Heyman. Tues., 31 Jan., 5.30 p.m.*

Institution of Electrical Engineers

BIRMINGHAM
"Development of High-Voltage Air-Break Circuit Breakers with Insulated-Steel Plate Arc Chutes," by F. S. Fay, J. A. Thomas, D. Legg and J. S. Morton. South Midland Centre. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Mon., 6 Feb., 6.30 p.m.*
MANCHESTER
"A Basis for Short Circuit Ratings for Paper Insulated Cables up to 11 kV," by L. Gosland and R. G. Parr; and "Short-Circuit Ratings for Mains Cables," by G. S. Buckingham. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 31 Jan., 6.15 p.m.

Institution of Engineering Designers

LONDON
"Some Aspects of the History of Engineering Drawing Leading to Drawing Standardisation," by P. J. Booker. Thurs., 2 Feb., 7 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"The Interdependence of Engineering and Chemistry," by Sir Alexander Fleck. Tues., 31 Jan., 6.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Design and Application of Natural and Mechanical Convectors," by B. T. Jones. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Tues., 31 Jan., 6.30 p.m.
LEICESTER
"School Heating": discussion, to be opened by J. H. R. Parris. East Midlands Branch. College of Technology, Leicester. Wed., 1 Feb., 6.30 p.m.

Institution of Highway Engineers

LONDON
"Lessons Learned on the Design, Construction and Maintenance of Motorways"—Part III, "From the Contractor's Angle," by W. Kirby Laing. Institution of Structural Engineers, 11 Upper Belgrave Street, SW1. Fri., 3 Feb., 5.30 p.m.
LEEDS
"Design and Execution of Road Improvements in Urban Areas," by S. G. Wardley. Yorkshire and Lincolnshire Branch. Griffin Hotel, Leeds. Thurs., 2 Feb., 7 p.m.

Institution of Mechanical Engineers

LONDON
"Quality Control": discussion, to be opened by F. Nixon. Automobile Division. Tues., 31 Jan., 6 p.m.*
LOUGHBOROUGH
"Potentialities of Accurate Measurement and Control in Engineering," by Professor J. Loxham. East Midlands Branch. College of Further Education, Loughborough. Thurs., 26 Jan., 7.30 p.m.
MANCHESTER
"Pressure Vessels for Gas-Cooled Graphite Moderated Reactors," by M. Noone and R. Bishop. Apartments of the Literary and Philosophical Society, George Street, Manchester. Thurs., 26 Jan., 6.45 p.m.
READING
"Organising and Designing for Safety in the Engineering Industry": discussion, to be opened by H. van der Vord. Southern Branch. Technical College, Reading. Wed., 25 Jan., 7.30 p.m.

Institution of Plant Engineers

LONDON
"Standards in Plant Engineering," by Dr. E. L. Diamond. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 7 Feb., 7 p.m.*
EDINBURGH
"Engineering in the Petroleum Industry," by W. M. Greenhorn. Edinburgh Branch. 25 Charlotte Square, Edinburgh. Wed., 1 Feb., 7 p.m.
LEEDS
"Uses of Molybdenum Disulphide," by G. J. Vineall. West and East Yorkshire Branch. Houldsworth School of Applied Science, The University, Leeds. Mon., 30 Jan., 7.30 p.m.

Institution of Production Engineers

ACCRINGTON
"Gears," by H. R. Stansfield. Preston Section. College of Further Education, Accrington. Wed., 8 Feb., 7.30 p.m.
COVENTRY
"Automatic Equipment in the Metal-Finishing Industry," by S. H. Grindrod (with films). Coventry Graduate Section. Courtaulds Lecture Theatre, Lockhurst Lane, Coventry. Tues., 7 Feb., 7.30 p.m.
MANCHESTER
"The Design of Bluebird," by Donald Stevens. Manchester Section. College of Science and Technology, Manchester. Mon., 30 Jan., 7.15 p.m.

Institution of Structural Engineers

BIRMINGHAM
"Structural Engineering in the Construction of the Inner Ring Road," by S. G. Piggot. Midland Graduates' and Students' Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Fri., 3 Feb., 6.30 p.m.
CARDIFF
"Multi-Storey Car Parks," by E. C. Roberts. Wales and Monmouth Branch. South Wales Institute of Engineers, Park Place, Cardiff. Thurs., 2 Feb., 6.30 p.m.
SWANSEA
"Planning and Design of the Central Market, Swansea," by Howell Menders and J. M. Burke. Wales and Monmouth Branch. Mackworth Hotel, High Street, Swansea. Wed., 1 Feb., 6.30 p.m.

Junior Institution of Engineers

BIRMINGHAM
"Industrial Insurance," by B. Chellingworth. Midland Section. James Watt Memorial Institute, Great Charles Street, Birmingham. Wed., 1 Feb., 7 p.m.

Liverpool Metallurgical Society

LIVERPOOL
"The Origin and Solution of Some Industrial Corrosion Problems," by E. C. Campbell. Department of Metallurgy, The University, Liverpool. Thurs., 9 Feb., 7 p.m.

Newcomen Society

LONDON
"The Draining of the Alport Mines, Derbyshire," by Miss Nellie Kirkham. Wed., 1 Feb., 5.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"Fatigue Strength of Marine Shafting," by G. P. Smedley and B. K. Batten. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 27 Jan., 6.15 p.m.

Reinforced Concrete Association

EDINBURGH
"Lift Slab Design and Construction," by F. R. Benson. Scottish Branch. North British Hotel, Edinburgh. Tues., 31 Jan., 6.30 p.m.*

Royal Aeronautical Society

LONDON
"Economics of Agricultural Chemicals and Fertilisers," by J. C. Pinder. Agricultural Aviation Group. Wed., 1 Feb., 7 p.m.
SWINDON
"Nuclear Propulsion for Aircraft," by A. D. Baxter. Swindon Branch. The College, Victoria Road, Swindon. Thurs., 2 Feb., 7.30 p.m.

Royal Institution of Naval Architects

LONDON
"Sea Trials on Two Cross-Channel Twin-Screw Ships," by Prof. Ir. G. Aertssen. Thurs., 2 Feb., 4.45 p.m.

Royal Society of Arts

LONDON
"The Chemical and Plastics Industry," by Dr. James Taylor. Cantor Lecture. Mon., 30 Jan., 6 p.m.

Royal Statistical Society

SHEFFIELD
"How Can Statistics Help the Manager?" by P. J. Stanley. Sheffield Group. Sheffield University, Firth Building, Western Bank, Sheffield. Thurs., 26 Jan., 7 p.m.

Royal United Service Institution

LONDON
"The Deterrent and Disarmament," by the Hon. Alastair Buchan. Wed., 1 Feb., 3 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Tool Steels," by G. Hoyle. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 31 Jan., 7 p.m.

Society of Instrument Technology

LONDON
"Instrumentation: Past, Present and Future," by L. S. Yoxall. Manson House, 26 Portland Place, W1. Tues., 31 Jan., 7 p.m.*
FAWLEY
"Instrumentation in Radio Astronomy," by Dr. H. P. Palmer. Fawley Section. Administration Building, Esso Refinery, Fawley. Fri., 3 Feb., 5.30 p.m.
SHEFFIELD
"Some Aspects of Instrumentation in Steelworks," by Dr. R. H. Baulk. South Yorkshire Section. The University, St. George's Square, Sheffield 1. Mon., 6 Feb., 7 p.m.
WIRRAL
"Satellite Instrumentation," by Dr. R. C. Jennison. Chester Section. Administration Building, Associated Ethyl Co., Ltd., Oil Sites Road, Ellesmere Port, Wirral. Thurs., 26 Jan., 7 p.m.

Television Society

LONDON
"Behind the Eye," by Professor D. M. Mackay. Fleming Memorial Lecture. Royal Institution, 21 Albemarle Street, W1. Thurs., 26 Jan., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Petroleum, 61 New Cavendish Street, London, W1. (LANgham 3583)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London, EC4. (CENtral 4694)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road, St. Helens, Lancs. (St. Helens 5879)
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tune 1. (Newcastle 20289)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Royal United Service Institution, Whitehall, London, SW1. (WHItehall 5854)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330)

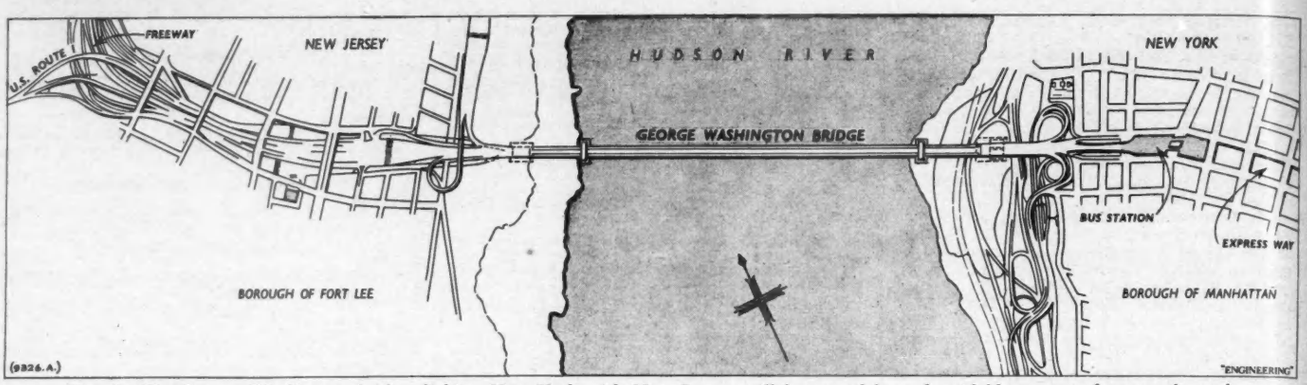


Fig. 1 The George Washington bridge, linking New York with New Jersey, will be served by a formidable system of approach roads.

Bridge Traffic Grows?—Sling a New Deck

The traffic capacity of the George Washington bridge in New York is being increased 75 per cent by the addition of a lower deck. Extensive new approaches are being built.

More than 30 years ago, when the designs for the George Washington suspension bridge were being finalised, the New York authorities foresaw the growth of road traffic and made provision for a possible second lower deck to be hung on the bridge. The bridge was opened in 1931 and in 1932, the first full year of operation, 5½ million vehicles used its eight lanes to cross the Hudson River. By 1959 this figure had increased to within a few hundreds of 38½ million, very close to the capacity of the bridge.

A study in 1955 on arterial facilities by the Port of New York Authority, who built and own the George Washginton, and the Triborough Bridge and Tunnel Authority concluded that traffic in the area could best be served by providing additional bypass routes north and south of the congested areas of Manhatten. One of the solutions was the provision of six extra traffic lanes on a second lower deck across the George Washington bridge, together with new high and low level approaches on both sides of the river. Some idea of the complexity of the main thoroughfare system, with its expressways, freeways, and with the US National Route 1 commencing on the west side, is given by the map, Fig. 1, above.

When the project is complete in 1962, the bridge will provide three extra traffic lanes in each direction and its capacity will have been increased by 75 per cent. The cost of the lower deck and its approaches is put at $183 million, of which $25 million is for alterations to the bridge itself. Work has been planned in stages so that new roads can be brought into use as they are finished.

The layout of the approaches has been governed by three criteria. First, that the two middle lanes of the upper deck would continue to be reversible as they have been in the past; thus a total of eight lanes, five above and three below, will be available for traffic using the bridge in the direction of heavier flow. Second, that motorists could use either the upper or lower level to reach any of the highways. Third, which follows as a corollary from the second, is that, without inconvenience to motorists, the lower level could be closed at times when traffic is light.

The bridge has a main span of 3,500 ft which, at the time it was opened, was the longest in the world; it was soon exceeded by the Golden Gate bridge (4,500 ft) in San Francisco, and it is now the third longest. The final designs of the late 1920's contemplated seven lanes of vehicular traffic on the top deck, but by narrowing the side lanes and rearranging the central kerbs, an eighth was obtained. Beneath the deck, and to be connected to it by rigid frames, provision was made for a lower deck to carry " four tracks of heavy rapid transit trains or additional vehicular lanes should that ever become necessary."

This decision was reached after calculations, supplemented by observations on a model, had shown that the initial omission of the trusses and

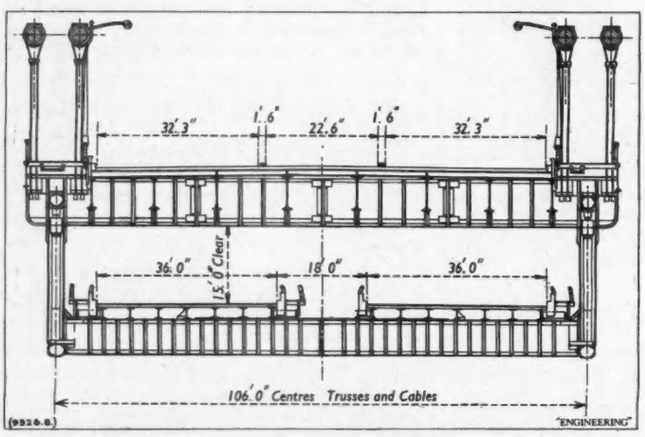


Fig. 2 (left) Cross-section of the bridge after the addition of the lower deck, giving 14 traffic lanes, eight above and six below. The two middle lanes of the upper deck are reversible to meet traffic demands.

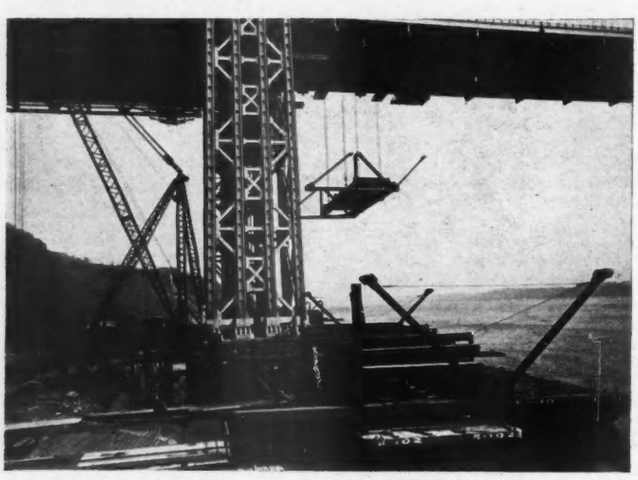


Fig. 3 (left) Erection of the lower deck steel. Each section was assembled on the ground or on a barge and lifted into position. The photograph shows the first New Jersey main span section being raised.

Fig. 4 (right) The first section of the main deck in position, though still supported by the lifting blocks. The headroom over the new road surface is 15 ft.

the second deck would still secure adequate rigidity of the structure. The cost in 1931 of the bridge and its approaches was just short of $55 million, of which $15 million was expended in providing means for the future increase of the capacity of the bridge and its approaches. In retrospect, this additional outlay has proved to have been more than well spent.

To meet all the requirements of the alterations, means have had to be found for reducing the deadweight of the structure (the all-up deadweight of the two decks is 47,000 lb per foot of span). One such measure has been to resurface the concrete deck with ½ in of silica sand asphalt, which weighs only 500 lb per ft of span (the road width is 90 ft), against an allowed figure of 3,100 lb per ft for wearing surfaces. For the new deck, a 4½ in deep steel grid filled with lightweight concrete and with 2 in of asphalt surfacing, saves considerable weight compared with a less expensive concrete floor. It is of interest to note that the use of precast prestressed concrete slabs set directly on the floor steel was considered. It did not prove possible by this means to effect the weight savings required but the designers believe that, given detailing which will ensure firm bearing on the steel and adequate shear connection, this will be the accepted bridge floor of the future.

Further weight saving came with the introduction of an intermediate floor beam which halved the stringer length and thereby reduced considerably the section required. Also, aluminium as been used for the footpath gratings and handrails.

In the original upper deck construction, the wind truss comprised the upper chords of the future stiffening trusses and associated diagonal bracing. It had not been planned to provide a bottom lateral system in the two-deck bridge, it being assumed that wind loads on the lower deck would be transferred to the upper structure. Further consideration has shown the desirability of such a framing and it has been built into the plane of the bottom chords.

Structurally the towers were always sufficient to take the loads imposed by the two decks but the location of the cable saddles at the top of the towers has had to be adjusted to compensate for the changing eccentricity of the load as the towers moved riverwards under the action of the increasing loads from the second deck. (Much of the required movement has been obtained by deflecting the 593 ft high powers. A total movement of 13½ in has to be obtained before traffic uses the lower deck.)

Computations for suspension bridges—for the deflection of the cable and the main truss, to determine the components of the cable load under varying combinations of live load—have previously had to be undertaken by trial and error. For the alterations to the George Washington, however, a programme was developed using the Bell system on an IBM 650 digital computer with all the attendent advantages.

The new deck was put into position in 76 sections that were each 90 ft long, 108 ft wide and 30 ft deep, weighing 220 tons; the first river span section is shown in Figs. 3 and 4 being raised into position. The sections consist of two built up girders, two posts, four diagonals, two 60 ft box-section lower chords and the floor steel comprising lateral bracing, stringers, grid floor and footpath supports. For the river spans, these sections were assembled on barges floated out to a point below their final location and raised directly into position. In the case of the tail spans, the circumstances were somewhat different. In particular only small assembly areas were available close to the foot of the towers and the situation was further complicated by the existence of road and rail systems running parallel with the river. Sections were raised on four point pick-ups and rolled, sometimes as much as 600 ft, under the tail spans to the erection point while the traffic below was diverted or held in check.

Fig. 5 (left) Construction work in progress for the new ramp to the upper level of the bridge on the New York side.

Fig. 6 (right) An aerial view showing the New York approach east of the bridge. Though the roadways are now partly in operation, there is a considerable amount of construction work still to be done before the approach is completed. The project as a whole is due for completion in 1962 and will increase the traffic capacity of the bridge by 75 per cent.

In the case of the first section to be erected, for the tail span on the New York side, lifting the section took 1 hour 45 minutes and it was rolled the 600 ft to the abutment in under 40 minutes. Fixing in position took 8 hours. Lifting was done in daylight but rolling was done in the early hours of the morning while traffic below was light.

The lifting and carrying mechanism consisted of two 106 ft long trolleys similar to those used on overhead cranes. These trolleys ran on heavy I beams temporarily suspended from the upper deck of the bridge but which were subsequently lowered for use as stringers in the new deck. Each trolley carried a 200 hp three-drum hoist. Two of the drums served the four 15 fall blocks and tackle used for lifting the steelwork and the third controlled a double whip pulling line that passed through a sheave at the anchorage and returned to a dead end at the trolley.

Altogether, the new deck called for the erection of 17,437 tons of steel, including 3,300 tons of floor grid. Connections of new members to the existing gusset plates of the top chord were riveted, the use of high tensile steel bolts being found impracticable because of the many coats of paint that had been applied over the years and the difficulty of removing them. Connections of the truss members at the bottom chord joints were made with high strength bolts, proper tension being obtained by turn of the nut methods. Placing of the fill-in steel for the deck was accomplished using a lorry mounted crane of 35 tons capacity working with its boom nearly horizontal within the 15 ft headroom that was available.

The lower deck has been designed and erected by the Port of New York Authority under the supervision of the Authority's chief engineer, John M. Kyle, F.ASCE. The contract for the fabrication and erection of the steel was let to the Bethlehem Steel Company and shop work was done at their Pottstown, Pa., works.

In conjunction with the second deck, additional road connections and toll facilities have been required. Handling time at the toll booths is to be surprisingly short, averaging only 11 seconds per vehicle; economy has also been effected by the discovery that left-hand booths are significantly more efficient than a combination of left and right-hand booths, thus enabling the number of booths, and the space allotted to them, to be reduced.

In addition to the map opposite, an aerial view of the New York approaches that are nearly complete, Fig. 6, shows something of the road system that has been devised. So complex was the problem of visualising the relationship between traffic and completed areas, and of scheduling the work, that recourse was made to a large scale model for staging the construction. Fig. 5 shows one of the many ramps on the New York side under construction; the steelwork has subsequently been encased in concrete.

A major feature of the project is the George Washington bus station, the first work of Dr. P. L. Nervi, the Italian engineer-architect, to be built in New York. Two blocks long and three storeys in height, it will straddle the expressway on the east bank. The sides of the raised roof and of the bus station itself will be exposed precast structural sections, forming an open framework that will assist ventilation of the bus platforms and of the expressway below.

The Port of New York Authority Commissioners gave their permission for work to begin in July, 1957, and construction actually began at the end of that year. Erection of the bridge steelwork began at the beginning of 1960 and work on the bridge itself is now virtually complete. Completion for the whole scheme is scheduled for 1962.

Thames Estuary Crossing by Supergrid

Taking the supergrid over the Thames estuary involves a 4,500 ft span for the 275/400 kV conductors.

THE West Thurrock crossing of the River Thames with 275 kV cables is an essential part of the continuance of the supergrid into South Eastern England and will also form the closure of the 275 kV "ring" around London. The new line, of which the crossing forms a part, starts at the Central Electricity Generating Board's station at West Thurrock on the north bank of the Thames and is carried over to Northfleet by the special conductors of the crossing before continuing as a standard 275 kV line via Canterbury to Lydd, with connections to the cross-Channel cable links and to the nuclear power station now under construction at Dungeness.

The design and erection of the line has taken account of the Board's recently announced policy of uprating the supergrid from 275 kV to 400 kV, a policy which has been adopted in order to increase transmission capacities and to minimise the number of grid lines required, thus reducing interference with amenities to a minimum. The Thames crossing consists of two 615 ft towers of high tensile steel, 4,500 ft apart, which support the conductors at the necessary height to gain the stipulated river clearance (250 ft as required by the Port of London Authority) and two anchor towers which take the strain of the crossing conductors.

The standard conductors which the CEGB employs for the 275 kV supergrid are twin 0·4 sq. in steel cored aluminium conductors per phase. While these would not provide sufficient strength for the 4,500 ft span of the crossing, the experience gained by the Board of this type of conductor led to the development of a 199 stranded steel cored conductor, using 91 to 120 tons per sq. in steel wires as core, with 108 strands of aluminium arranged in three layers over the core. This conductor matches in capacity the twin conductors of the incoming lines and has sufficient diameter (2·262 in) to accommodate the maximum operating pressure of 400 kV without corona losses arising. Its high mechanical strength, necessary to obtain an economic sag, is shown by the calculated ultimate strength of 290,000 lb, and the equivalent modulus of elasticity of $14{\cdot}25 \times 10^6$ lb per sq. in. Its maximum working tension is 97,200 lb. In making the design, account was taken of aerodynamic effects expected with such long spans in addition to the more routine meteorological aspects. The design radial thickness for ice loading is 0·5 in and the wind loading figure on 80 per cent of the wind span is 15 lb per sq. ft.

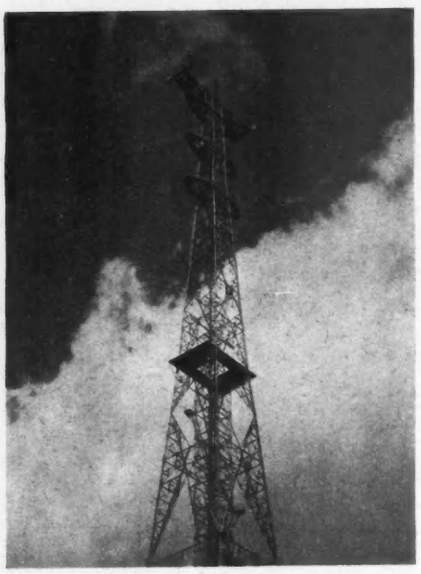
TOWER DESIGN

The two crossing towers are square in plan, the base being 100 ft square, and the height being 615 ft. The overall length of the top cross-arm is 74 ft. Each tower consists of 21 main leg sections, between 25 and 31 ft in length, making 11 panels. The lower five panels take the form of modified K bracings, these being followed by a series of open-diamond and scissor-braced panels. The graceful shape of the tower is governed by a change of leg slope at every second panel, i.e., every 125 ft; it was both convenient and desirable to use such an interval to enable aircraft obstruction lights to be sited at the main horizontal bracing members at these levels. The steelwork comprises standard galvanised high tensile steel rolled sections conforming to BS 548. It has been fully site assembled.

The anchor towers are also fabricated from high tensile steel, these towers each consisting of four panels of 30, 41, 41, and 33 ft high, each panel forming an open-diamond structure. The function of these towers is that of a frame to which the crossing conductors are secured. They are, however, provided with three pairs of auxiliary cross arms which support the "jumpers" or connections between the incoming lines and the crossing conductors. The detail design of both crossing and anchor towers was made by Blaw Knox Limited.

Mounted at the end of the suspension tower cross arms are universal bearings from which the insulator assemblies are hung. These insulator assemblies, manufactured by Bullers Limited, will have jacking equipment to allow the insulator strings to be removed for servicing, and inspection of the universal bearings will also be possible without disturbing the insulators.

The foundation work for the towers was started on both sides of the river early in 1959,



Top section of a crossing tower, showing conductor cross arms and the maintenance platform.

tower construction commencing in August, 1959. The foundations for the crossing towers consisted of 30 reinforced concrete piles, 17 in square, at each of the four legs of the tower; and at the anchor towers 100 piles are provided at the rear to resist overturning forces. The piles were taken 40 ft deep on the north side and to 45 ft on the south bank. All four towers are aligned to within ¼ in over a total length of 7,700 ft (the crossing span is 4,500 ft and each anchor span 1,600 ft). The spans were checked with a geodetic theodolite, a telurometer being finally used to check span distance over the 4,500 ft to within 3 in. The exceptional accuracy of alignment was obtained by mounting neon tubes vertically on masts at each site and aligning these by night-time theodolite observation under VHF radio control.

Building of each crossing tower by British Insulated Callender's Construction Company Limited began with the erection of the first 125 ft of the central column and an 80 ft derrick was mounted in a lifting rig on the column for the erection of the first 60 ft panel of the tower. When this panel was complete, the central column was advanced another 60 ft, the luffing derrick also raised 60 ft, and erection continued on the second panel of the main structure. Above 350 ft, this derrick was used as a floating rig for the main construction. The structure uses GKN high tensile bolts run with ratchet spanners.

The winching duties for raising all men and components at the crossing towers is carried out by a modified Sykes No. 8 winch powered by a Lister FR 4 engine. Another Sykes No. 7 winch, powered by a Ruston 3YC engine, is used as an auxiliary on each tower. The main Sykes winch is reeved on a 3 to 1 reduction tackle, the maximum lift to date being 3½ tons. The maximum bond length is 4,100 ft, the drum speed being 120 to 150 ft per min, giving a lifting speed of 40 to 50 ft per min. The bond used is ½ in diameter steel wire rope in 10 laps. At the anchor towers the main winch is a Sykes No. 7 winch, the auxiliary being a No. 6 size. The main winch here is reeved as at the crossing tower and the maximum lift of 3 tons will be for the top main truss. A 3,000 ft bond length was provided with this winch to enable it to be used for lifting the insulators of the main tower

The most intricate phase of the construction of the crossing towers was the erection of the top maintenance cross arm, which required an additional derrick at the 600 ft level. The cross arm was erected, section by section, 615 ft above the ground, the first sections being stayed. When this unit was completed, the six lower insulator cross arms were raised into position. These units each weighed 2½ tons and were pre-assembled on the ground.

ERECTING THE CONDUCTORS

The procedure to be adopted for running of the conductors will consist of laying a track and haulage rope in the river, with each end being passed over the tops of the crossing towers on wheeled paddles. At times agreed with the PLA the river will be closed and these ropes will be hoisted out of the water and tensioned by winches and tackle at the rear of the anchor towers. The haulage rope and track rope will then be "stitched" together by a set of trolleys which run on the fixed track rope and are pulled by the moving haulage rope. When the system is completely stitched and ready, it will carry the conductors by a second set of suspension trolleys which will be hauled over the crossing, the suspension trolleys being fed on at one end and the stitching trolleys being removed at the other end. The conductor drum will be mounted on the north bank and the haulage winch on the south bank. (All operations will be directed by VHF radio control and there will be as many as six radio sets maintaining contact between the teams on the ground and at the tower tops.

One of the conditions of the contract is that no conductor shall touch water or land at any stage, this being necessary due to the need to prevent any possibility of damage to the cables and thus giving rise, among other things, to corona losses. As each conductor is received across at the far anchor tower, it will be tensioned at both ends and released from the suspension trolleys. This is possible as the sag of the track rope system will be greater than the sag of the conductor in its service position. Tension and suspension insulators will then be inserted at the anchor and crossing towers and the track rope and trolley prepared for the next conductor by reversing the haulage rope, re-attaching the stitching trolleys and recovering the suspension trolleys at the north bank anchor tower.

The main contractors for the CEGB are British Insulated Callender's Construction Company Limited, the detail tower design being by Blaw-Knox Limited. Steelwork for the suspension towers was fabricated by Horseley Bridge and Thomas Piggott Limited, and that for the anchor towers was fabricated by Painter Brothers Limited. The foundation design consultants were Sir Alexander Gibb and Partners, the foundations being emplaced by Holloway Brothers Limited and Mears Brothers Limited. The conductors are being supplied by British Insulated Callender's Cables Limited, and the conductor erection equipment by John Barnsley and Company Limited. The anchor clamps, armour rods and vibration clampers are supplied by Alcan Industries Limited, and the insulator assemblies manufactured by Bullers Limited.

Human Element

The Rising Demand for Most Technicians

DEMAND for technicians in industry is likely to be about twice as high in January, 1962, as in January of last year. This is the estimate given by employers taking part in a sample survey on demand for technicians conducted by the Ministry of Labour.

The inquiry was carried out last year and the firms concerned were engaged in the engineering industries, shipbuilding and chemicals. In the iron and steel and other metal manufacturing companies the numbers wanted early next year are expected to be as much as four times those of January, 1960; by the time these needs had been satisfied there would be an increase of a fifth in the number of technicians employed in this sector of industry.

Among the shipbuilders taking part there were many who were not sure that they would need any increased number of technicians over the next two years.

Firms included in the survey employed over 20 per cent of the labour force of their industries. Through the overall sample technicians were found to number 8·7 per cent. About a tenth of the employees of the aircraft companies and the car manufacturers are technicians and this proportion rose to higher levels in electrical engineering.

The proportion of technicians employed in relation to qualified engineers and scientists varies from industry to industry. From around seven technicians to each scientist or engineer in aircraft, motors and railway equipment the proportion fell to one or two in chemical undertakings. Some very big variations in engineer-technician ratios were observed within industries, and even between firms of similar size.

Some 14 per cent of the technicians held the Higher National Diploma, Higher National Certificate or similar qualifications and there were almost 60 per cent who were without qualifications or were still studying.

BISF President is Guest Keen Chief

This year's president of the British Iron and Steel Federation is Mr. Charles R. Wheeler, a past-president of the Iron and Steel Institute (1958-59) and a former Government representative on the steel committee of the Economic Commission for Europe and the Committee of European Economic Co-operation.

The new president's present positions include the chairmanship of Guest Keen Iron and Steel, additional vice-chairman of Associated Electrical Industries, and a director of the Steel Company of Wales. Mr. Wheeler is taking up executive duties with AEI in 1962 and is resigning from the Guest Keen Iron and Steel chairmanship at the end of this year. He will stay on the board of Guest Keen and Nettlefolds.

Going into the steel industry from St. Paul's in 1922, Mr. Wheeler had become a director of the then Guest, Keen, Baldwins Iron and Steel Company by 1940. During the war, Mr. Wheeler was employed in the Iron and Steel Control of the Ministry of Supply, first as assistant controller, raw materials, then as deputy controller from 1943, the year in which he led the British delegation to the Joint Metallurgical Committee in the United States. In 1945 he became Controller of Iron and Steel.

Thirteen years after returning, in 1946, to Guest, Keen, Baldwins as joint managing director, he was appointed, in December, 1959, chairman of the company, now named Guest Keen Iron and Steel.

A member of the council and executive committee of the British Iron and Steel Federation since 1946, Mr. Wheeler has been chairman of BISC (Ore) since its formation in the same year. He has also been chairman of the Federation's international trade relations committee since 1958.

Last year's president was Mr. R. F. Summers, chairman of John Summers and Sons. Sir Julian Pode, managing director, the Steel Company of Wales, is the Federation's president-elect.

MTTA's New Education Officer

The education officer appointed by the Machine Tool Trades Association is a man of formidable qualifications.

Head of the Department of Mechanical Engineering at the Borough Polytechnic, London, before joining MTTA, Mr. G. L. H. Bird, who is shortly to set out on a tour of industry, has been in technical education since 1947.

Graduating with honours in mechanical engineering from University College, London, in 1931, Mr. Bird was in industry as a mechanical engineer until the Second World War broke out. For the next few years he was a Squadron Leader in the technical branch of the Royal Air Force and then in 1947 joined the staff of the National College for Heating, Ventilating, Refrigeration and Fan Engineering, remaining there until 1956.

Inevitably it will be said that the MTTA's education officer should have an accurate idea of what is going on among overseas competitors. Mr. Bird has had ample opportunity to get to know more than most about this, and foreign conferences to which he has contributed read like a Grand Tour—Baden-Baden, Belgrade, Copenhagen, Delft, Heidelberg, Mons, Moscow, Padua, Paris, Turin and Zurich.

At home Mr. Bird is a member of the Education Group Committee of the Institution of Mechanical Engineers, a council member of the Institute of Refrigeration and chairman of that Institute's education committee. A former technical school governor, Mr. Bird also serves on a number of committees of the British Standards Institute.

The MTTA recalls that the machine tool industry took an important step in its technological education when it established scholarships each year for a two-year post-graduate course at Manchester University, a decision reached in 1959. The Association now expects that, as moves of this kind are extended, the number of qualified staff in the industry will increase. It is hoped that the industry will thus be felt to be a likely career prospect by those who are choosing a branch of engineering.

Mild Reform in Technical Education

The Government's White Paper, *Better Opportunities in Technical Education*, is described by Sir David Eccles, the Minister of Education, as writing a charter for technicians.

If the word charter is going to be used at all it would be useful to find that some teeth had been put into it. There is a sharp division in industry at the moment between the boys whose employers grant day-release and those who give only a refusal with oblique references to evening classes.

The ten-point programme of changes in the further education system, on the technical side, holds the promise of providing courses better suited to what the individual students, and industry, require. But as the White Paper itself acknowledges, one of the great problems is that of giving more time to studies.

The Minister, in launching the White Paper, said, " This is one of the problems we intend to tackle." Unfortunately, Sir David was unable to say when he is going to be able to help the boy refused time off for classes.

This suggests that the Ministry has its priorities upside down. A partially reformed way of going about the education of technicians is only of benefit in so far as the future technicians are able to attend the courses. Or to attend them under such conditions that they have a fair chance of qualifying. Which is not the case just now, as is borne out by the high rate of those failing or falling out.

The introduction of compulsory day release would bring forth a loud protest from a variety of quarters. But it is worth asking whether such opposition would be valid. The underlying reason for the concern about the poor showing so far of our technical education system is that it seems reasonable to hope that with better instructed technicians we shall have a more flexible, more productive industry, and perhaps get out of the red in our world trade.

Invalid Argument ?

Part of the argument against compulsory day-release would be that inevitably it would be another little upward push for costs. But would it?

A very high percentage of our exports, particularly from the engineering industries, are sent abroad by the largest and most progressive companies. To them day-release, close coordination of apprentice instruction with local technical colleges, full use of sandwich courses and many other educational operations are long established methods of obtaining a skilled labour force, which is as essential as working capital and new plant.

There is at least one way in which day-release as part of the normal method of technical education would help the firms who have set the pace. At present they suffer a steady drain of trained personnel who quite reasonably move off in the cause of self-advancement, sometimes to companies who take no part in day-release schemes. This is a one-way movement. If the companies who deny their young men the opportunity of tackling some of their further education during the day were required to take part in day-release it would be more equitable, both for the students and the more progressive companies.

The White Paper points out one long term job of education on which a start needs to be made: retraining for those operatives made redundant by changing needs. New courses indicated in the White Paper include those devised for particular industries. In the short term this is excellent. There are plentiful examples in new growth industries, and long established trades, of specialised skill, where the list of unfilled skilled vacancies is long and painfully unyielding. But techniques have a way of suddenly fading out as they become uneconomic in the face of new development. Technicians who have been specifically trained may well from time to time need retraining. For individual firms to go beyond releasing young men for education to accepting periods of paid release of their fathers will need a long effort of constructive public relations work.

Ten-Point Scheme

The Ministry's main proposals in the White Paper (Cmnd. 1254 HM Stationery Office, 1*s* 3*d*) are ten in number. They are:

1. Students should go straight from school to technical college. Evening institute preliminary courses should stop.
2. More care in selection of students for courses. Experiments with full-time induction courses and tutorial methods.
3. Courses to include:
   - National Certificate and Diploma courses for students intending to become at least high grade technicians;
   - Technician courses devised specifically for particular industries;
   - Craft courses;
   - Courses for operatives.
4. Ordinary National Certificate course to last two instead of three years. Entry standards to be raised.
5. New four or five year courses specially for technicians.
6. New general courses, leading to technician courses or to Ordinary National Certificate and Diploma courses.
7. Modifications to craft courses.
8. Vigorous development of courses for operatives.
9. More time should be provided under day-release schemes. No student should have to rely wholly on evening study. And
10. Increasing development of sandwich courses, especially for technicians, and of block release.

A number of examining bodies, among them the City and Guilds of London Institute, are carrying out the preparatory work for the new general and technician courses. The Ministry of Education has circularised the local education authorities and the main further education establishments pointing out that, in electrical engineering and telecommunications, the new technician courses are available for the 1961-62 session. It is also expected that the course in mechanical engineering will be ready for introduction in time to be used in the term beginning this September. This course in mechanical engineering is intended to replace the machine shop engineering course.

Considerable progress has also been made in preparing the new common general engineering course leading either into an Ordinary National Certificate course, or the new technician courses in mechanical engineering, electrical engineering and telecommunications.

Water Brings Backward Lands to Life

First in developing the resources of a country come food supplies, communications and electric power, to all of which hydraulics holds the key.

By A. N. M. Robertson, B.A. B.E., M.Inst.C.E.

Sir William Halcrow and Partners

HELPING backward countries to make the most of their resources is essentially an engineering problem. Even agriculture depends on irrigation, and only by the application of scientific methods can the land be brought to full productiveness. Often the first task in an underdeveloped area is to restore the fertility of land that has been allowed to go to waste. But although the land takes precedence, it is desirable to consider all the resources of a region, so that they may be developed within a single integrated scheme. Rivers are exploited both for irrigation and navigation; they are diverted to carry water into arid zones or for purposes of flood control, and are also a cheap and abundant source of power. Water makes growth possible—with the assistance of the hydraulics engineer.

Water and its part in the development of underdeveloped territories is the common factor of three recent publications: one is concerned with the unified development of a single backward region; the second with arid zone hydrology; and the third with the improvement of the rivers Niger and Benue.

The theme of the first book may be expressed in terms of an opinion offered by Serge Liliavsky in his preface to Volume 2 of *Irrigation and Hydraulic Design*, where he suggests that there have been three stages in the engineer's relation to irrigation. In the first stage, irrigation was regarded as a "farming art"; in the second, with the advance of technical research, it became an "engineering science"; and finally, the American approach has led to irrigation as a "farming science."

IRRIGATION AS A FARMING ART

India may be cited as an outstanding example of the increase in irrigated agriculture during the 19th and early 20th centuries, notably in Northern India, now known as Pakistan, where many millions of desert acres came under cultivation. The design and construction of such schemes were carried out departmentally by the Irrigation Branch of the Public Works Department, employing direct labour, and they were closely associated with the Building and Roads and Railway branches of the PWD. The Irrigation Branch had always been in charge of the operation and maintenance of the completed canal systems, and its revenue organisation dealt directly with the cultivators in inspection of crops for assessment of water rates, and in the various problems of sharing water among the cultivators, all-such matters being the responsibility of the engineering staff.

Any major irrigation project would have such an organisation as seemed necessary for development within the scheme. After scrutiny by the chief engineer in the irrigation branch and agreement by the heads concerned in the other technical departments and branches of the administration, fully prepared schemes were submitted for sanction by government. In the case of major projects they required the approval of the Government of India. When sanctioned they were financed from revenue or from government loans, and expenditure was controlled and supervised by the accounts department of a province. All these features in the organisation had their origin in a settled and experienced administration with direct support from the finances of the country. The technical services and departments had wide experience and long association with the problems of designing and operating such irrigation projects, and with these advantages very large areas of desert have come under cultivation. Such development has been mainly for peasant farming, though there were some estates with larger ownerships.

The term "backward" hardly seems applicable to such projects, except perhaps to the land, and as the peasantry had inherited a knowledge of agriculture they took their place in projects as a feature of "irrigation as a farming art."

AS AN ENGINEERING SCIENCE

There may be some difference of view about the causes of the change to "irrigation as an engineering science," if the words are taken to imply that engineers became more directly concerned with the advance of knowledge in hydrology and physics, and in their application to the purely technical problems of irrigation works design. It seems that it may be due to the change of circumstances, rather than to a modification of the engineers' outlook on the subject of irrigation. For instance, the moduling of outlets, the designs for silt exclusion, and for silt controlled channels are closely related to the delivery of water to the cultivators, and it is understood that the procedure for operation and maintenance of the canal systems of India and Pakistan and the engineers' association with the cultivators continues.

The first dam in an integrated river-control scheme is being built in Dez Canyon, Khuzestan under the general supervision of the Development and Resources Corporation.

This second stage may be taken as beginning from the period when irrigation research institutes were provided at Lahore and Poona and elsewhere and when the Sutlej Valley Scheme of about 5 million acres was being established in the Punjab. It still continues now, when other major projects are being built in India and Pakistan.

The result is a desire to grow profitable cash crops, and control of their production by a government department or a commercial syndicate. The interests of those concerned are specialised, and the engineer becomes less directly associated with the results of his work. But in any large scheme for producing cash crops, provision should be included for the individual peasant, who is mainly interested in food crops and his own livelihood. The Gezira Irrigation Scheme in the Sudan, where an area of one million acres has been developed for cotton growing by peasant farmers may be quoted as an example. This irrigation service was responsible for the design and maintenance of the canal system and for the accurate delivery of water to the head of the minor channels, and the inspectors of the Sudan Plantation Syndicate (subsequently of the Gezira Board) dealt directly with the tenants' crop cultivation and marketing of the cotton.

American practice has certainly taken the lead in the modern science of irrigation development, but such knowledge has become more general in its application in other countries. The *Report on the Unified Development of the Natural Resources of the Khuzestan Region* is an up-to-date record of very thorough investigations into improving irrigation in Iran.

This valuable report on the development of the natural resources of the province of Khuzestan in South West Iran has been prepared by the Development and Resources Corporation of New York. It was submitted to the Minister of Plan Organisation in the Iran Government after three years study of the natural advantages possessed by the region, and detailed investigations of the manner in which they could be developed to the best advantage as ascertained by the consultants' agents—the Khuzestan Development Service, and other firms employed by them to deal with special parts of the inquiries.

UNIFIED RESOURCES DEVELOPMENT

The report begins with an interesting account of the conditions in Khuzestan and of history related to it, and proceeds to state what the immediate objectives are for the first stage of improvement. They are defined as follows.

(1) The construction of a high-voltage transmission line from Abadan to Awaz to bring power from the thermal electricity scheme at Abadan, power being supplied by agreement with the National Iranian Oil Company. A special organisation named the Khuzestan Electricity and Gas Energy Company has already been sanctioned to control the power schemes.

(2) The construction of a multi-purpose dam on the Dez river, a tributary of the Karan. The dam will be of arch design, 190 metres high, storing 3·35 milliard cubic metres and with an initial hydroelectric power supply of 130,000 kW; 125,000 hectares of land will be irrigated from this source. The estimated cost of the dam is 6,200 million rials, equivalent to £31 million sterling and it is due to be completed by 1962. It is the key to the whole scheme for development of the region.

(3) Development of 10,000 hectares of irrigated sugar plantation on land already acquired by government within the 125,000 hectares of the irrigation scheme. A mill and refinery will produce 30,000 tons of refined sugar a year.

(4) A programme for the use of fertilisers to increase food and fibre production.

(5) The beginning of a petrochemical industry to produce plastic resin using natural gas.

It is proposed that electric power shall be obtained from a combination of hydroelectric schemes and by full use of natural gas as a fuel source for electrical energy. Natural gas would add 3·1 million kW. Fourteen dam sites have been selected on the five rivers in Khuzestan whose annual discharge to the plain is 35 milliard cubic metres, and these multi-purpose schemes will have a total installed capacity of 6·6 million kW. They would also have a minimum flow sufficient to irrigate 1 million hectares of land. There would also be great benefit from flood protection, which has not been fully determined as yet, but on the Dez river alone it has been estimated at £400,000 annually which should be reduced to about £25,000 to £50 000 owing to

construction of the dam. The estimated total cost is £565 million.

The full irrigation possibilities in Iran have been stated as being 1 million hectares and only about a quarter of this area could be supplied from the combined minimum flow of the five rivers, without dams. Other factors, soil, climate and the farming population, are favourable. It is evident that the right way to tackle it has been chosen in deciding to plan improvement for the large area of 124,800 hectares in the Dez Irrigation Scheme, where the population is accustomed to irrigation, and is sympathetic to the proposals; 91,400 hectares are under irrigation by them at present.

This policy compares favourably with tendencies elsewhere to select a few acres and study for several years the results of irrigation. Meanwhile local inhabitants are excluded from such use of their land.

A beginning is to be made in 33,000 hectares, and extensions are proposed for 9,000 hectares annually. The engineering features are for a diversion dam on the Dez and a canal layout which will remodel the present irrigation and drainage system. It is satisfactory to note that there is good drainage already, which helps the fertility of the land, and would check any tendency to waterlogging and salinity.

Farmers will pay water rates in future instead of the present custom of crop-sharing and it is expected that this canal revenue will meet the expenses of operating the scheme. It is known that elsewhere water rates no longer have sufficient values to cover interest charges on the capital cost of an irrigation scheme and that the economic benefit to a country has become a major consideration when sanctioning a project.

It is noted that when sufficient water has been stored, an additional development on the Kurkiheh, a neighbouring river, will be possible from the Dez supplies, and that 33,000 hectares can be irrigated by it. The cost of the 124,800 hectares scheme works out at £147 per acre, which is high, but the prospects seem favourable for a profitable return.

ARID ZONE HYDROLOGY

Arid zone research is the subject of a Unesco publication written by Professor H. Schoeller, Professor of Hydrology and Geology at the Bordeaux Faculty of Science. (*Arid Zone Hydrology: Recent Developments*, HMSO, 12*s* 6*d*) It is primarily intended for scientists engaged in research on the problems of ground water reservoirs in arid and semi-arid zones; but information of general interest is included in passages describing the formation of ground water reservoirs and their replenishment.

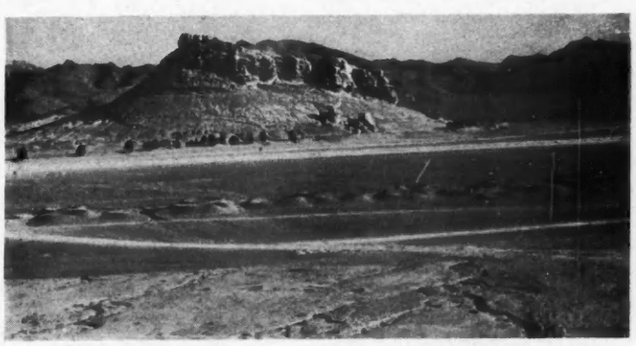
For those associated with its study the value of a combined knowledge of geology and hydrology is evident, for as stated by the author, the practical purpose of hydrology is to assess the total available water resources in a region, and to determine how they are to be developed: he considers that ground water is the key to life in semi-arid and arid zones. Thus permeability, transmissibility and geochemistry are treated in some detail. Descriptions of the use of tracers for determining the flow of underground water indicate the refinement of current procedures.

Possibly an engineer's attention will be attracted to a chapter on "Ground Water Prospecting and Development in Arid Zones," where three types of reservoir are mentioned and their characteristics discussed. They are classified as having the sources of their supplies from springs or wells and borings, and it is noted that it is only when there is motion in the subsoil water that replenishment will be possible, and that when there is no flow in an aquifer any withdrawal will deplete it. The author's views on the best arrangements for exploiting an underground reservoir are of interest: he advises the dispersion of the extraction points and their alignment across the full breadth of the aquifer.

The report, *River Studies and Recommendations for Improvement of the Niger and Benue*, was addressed by Netherlands Engineering Consultants of the Hague to the permanent secretary of the Federal Ministry of Transport in Nigeria, after 12 engineers of the consultants' staff had completed a three-year study in that country. A panel of experts in Holland, including three professors of hydraulics, had also been associated with the elaboration of the study and the presentation of the report, which is 978 pages in length, and is adequately illustrated by a series of diagrams, graphs, photographs and maps, showing that it is the result of a careful and thoroughgoing investigation. The report is published by the North Holland Publishing Company of Amsterdam.

The aims of the investigation are defined by the terms of reference agreed upon in 1954 by the Federal Government and the consultants and expressed as follows: "To carry out a general survey and investigation of conditions on the Niger and Benue system with the object of determining how shipping conditions on these rivers can effectively be improved." The proposals may be regarded as being the first step in a programme of major expansion of transport in the creeks and river, after the construction of the Escravos channel training works at the entrance to the Western Delta of the Niger to improve conditions for seagoing shipping, and to give access to ports in the Western Delta.

The two rivers rise beyond the borders of Nigeria. The source of the Niger is in Sierra Leone and that of the Benue in the French Cameroons, from where it flows as the Niger's largest tributary to join the main river at Iokuja. Their comparative sizes are shown in the table.



Arid region near Isfahan, Iran. In the foreground are a series of ventilation holes over a qanat or subterranean stream. A symposium on arid zones was organised last year by UNESCO. (Copyright UNESCO/Michel Méhard.)

River	*Drainage Area in square miles*	*Length in miles*	*Maximum Discharge in cusecs*	*Minimum Discharge in cusecs*
Niger ..	430,000	2,550	1,060,000	42,500
Benue ..	130,000	810	531,000	7,000

Their combined drainage area in Nigeria is said to be 222,000 square miles and to be equivalent to 60 per cent of the country.

The average annual rainfall for Nigeria is 45 in but it varies greatly throughout the country and comparable run-off figures are not available except at sites on the Benue, and they do not correspond to conditions on the Niger. There is only limited information at present about evaporation: but at Yola on the upper reach of the Benue an annual value of 65 in to 70 in is recorded with a high rate of 18 in during March.

The transport of sediment in the two rivers has been the subject of considerable study under the subheadings of "bed load," "suspended load," and "wash load" (silt). It is said that on the Niger and Benue the "bed load" is comparatively small, and they do not discharge large amounts of silt.

NAVIGATION

The improvement of river transport on the two rivers, being the chief purpose of the investigations, has been examined closely. The economy of Nigeria is based on agriculture and nearly all exports are of agricultural origin. The proportion of food crops to export crops is 15 to 1, with a ratio of 5 to 1 for their cash value. The tonnage of waterborne produce for export is said to be 275,000 tons annually.

As the terms of reference stated that river-borne traffic had a great influence in the economy of the country (which it undoubtedly has), it was somewhat surprising to read that "river transport is a relatively small part of the total transport in Nigeria." The proportions for road, rail and river being 10 : 8 : 1. Owing to the seasonal changes of discharges in the two rivers, the traffic varies in intensity, and larger quantities of produce are offered for shipment on the Niger during the period November to February-March than subsequently. The Benue is not navigable until June and its season for river transport ends in October or November.

Accordingly, the fleets of river craft work on each river alternately through the year. The report also notes that produce must be sent by rail during the low-water season as the rivers have become unnavigable. The Niger is useful for commercial shipping on 75 per cent of its length in four navigable stretches.

The river craft employed on the Niger and Benue are operative only about 50 per cent of the year, because neither night navigation nor night shifts ashore are common practice.

The report summarises proposals for improving navigability under five headings: river management, dredging, temporary improvements, bed regulation, and discharge regulation.

(1) The appointment of a hydrological branch of the Inland Waterway Department is recommended for continuing hydrological and other observations, and more gauges are to be fixed. Daytime buoyage is proposed and navigation by night is envisaged.

(2) A regular programme of dredging will be needed when river transport has doubled or trebled in volume; but test dredging is recommended by contract at an early date.

(3) The use of Fascine mats at the junction of the Benue with the Niger is proposed.

(4) In due course a series of groynes and training works will be needed for bed regulation, but this is a long-range measure.

(5) Discharge regulation would be accomplished by storage at dam sites, one on the Niger and two on the Benue in Cameroons territory.

The probable cost of these improvements has been estimated as follows: River management: £75,000 for the next 3 to 5 years, as a lump sum with an increase of present expenditure for 10 years; capital expenditure £900,000; annual charge £200,000.

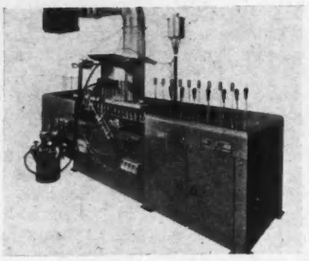
Discharge regulation: the Jebba Dam on the Niger is a multi-purpose scheme and is outside the terms of the investigation; the Lagdo Dam costs are put at £6 million and the Yola Dam at £10 million to £16 million; both of these proposals are on the Benue and in French territory.

Several benefits result from these measures. A 10 to 15 per cent lengthening of the river transport season is expected from the developments in river management. A 60 per cent increase in the capacity of the fleet is expected from night buoyage and night signalling.

Advantages in discharge regulation are claimed from the construction of the three dams: but the proposals had their drawbacks and it seemed they were unlikely to be sanctioned readily. It seems therefore that the real improvements fall under the heading of river management ,and no heavy capital expenditure on major works is suggested in the near future.

PAINT SPRAYING MACHINE

Continuous Action



CONVEYOR transport is included in a new automatic spraying machine.

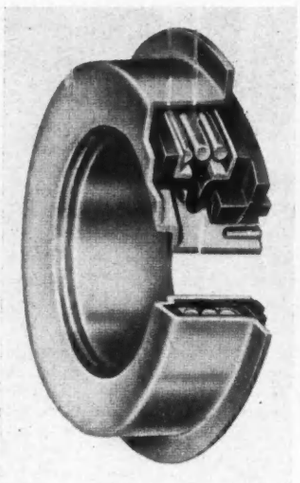
Each basic unit consists of a conveyor track and a spraying station comprising one spray gun, the gun traverse motion and a down draught exhaust system. Two motors provide the power; one drives the chain through reduction gearing, the gun motions and the operating valve. The extent of the gun motion is determined by the shape of the operating cam and the length of spraying time is infinitely variable, also by adjustable cams. Compressed air at 60 lb per sq. in is required for the gun and the valves.

The unit can be fitted with a chain of 2 in, 3 in, 4 in, or 6 in pitch to suit the components being sprayed. The standard model has a total chain length of appoximately 25 ft. The conveyor is in constant motion and the gun follows it while spraying. The gun cylinder arms are hydraulically powered and the motion is altered by changing or adjusting cams. Calibrated gun arms allow predetermined changes to be made. Extra gun motions can be fitted if required.

A mechanically operated memory device is available which will automatically signal if the workholder is not loaded, providing a safety and economy measure. The down draught exhaust system is ducted vertically through the centre of the machine, opposite the paint spraying station. Paint laden air is carried to the castor-mounted separator, and the cleaned air is vented to atmosphere. The machine can also be supplied for use with a stoving oven or for connection to an air drying station. *Alfred Bullows and Sons Limited, Long Street, Walsall, Staffordshire.*

SHAFT SEAL

High Speeds



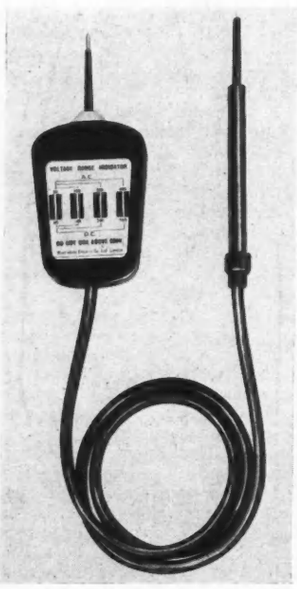
MASS produced mechanical type shaft seals are now on the market.

These seals are designed for operation at pressures up to 75 lb per sq. in and temperatures normally not exceeding 100° C. There are two forms, type 106 which is shaft mounted and rotates with the shaft, and 106A (illustrated) which is for press-in mounting and remains stationary. Both are suitable for a wide range of liquids or gases of a non-corrosive or mildly corrosive nature, providing the rubber components are not attacked.

Type 106 is useable with shaft speeds up to about 3,000 rpm and type 106A up to 5,000 rpm. The former is available for shafts of $\frac{1}{2}$ in, $\frac{5}{8}$ in, $\frac{3}{4}$ in and 1 in diameter and the latter for diameters of $\frac{5}{8}$ in, $\frac{1}{2}$ in, $\frac{5}{8}$ in and $\frac{3}{4}$ in. In type 106 sealing is maintained by spring pressure and flexibility is achieved by the incorporation of synthetic rubber bellows consisting of a single convolution. Positive drive is imparted by a drive ring that grips the shaft. In the type 106A this ring is replaced by a metal retainer allowing the entire assembly to be press-fitted. Vibration has no effect on the seal. *Crane Packing Limited, Slough, Buckinghamshire.*

VOLTAGE RANGE INDICATOR

ac or dc



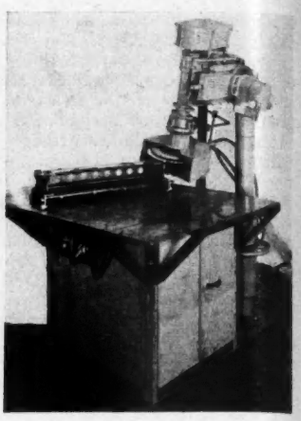
SHORTLY to be generally available is a voltage range indicator that will operate on both ac and dc systems.

The instrument has an operating range from 50 to 600 V at any frequency including those used in aircraft and missile control systems. The dial contains four neon tubes which light progressively as the voltage rises, the first for 50 V or over, the second for over 100 V and so on. These tubes are contained in a moulded plastics case measuring approximately $3\frac{1}{2}$ in by $2\frac{1}{2}$ in.

A retractable shrouded prod projects from the case and the second contact is made by a wander lead, at the end of which is a probe made up of a retractable insulated sheath covering a metal prod. The probe holder contains a fuse and a current limiting resistor. There are no moving parts in the instrument and all internal components are mounted on an insulated chassis. A high safety factor is claimed. *Martindale Electric Company Limited, Westmorland Road, London, NW9.*

PROFILE POLISHER

Automatic Action



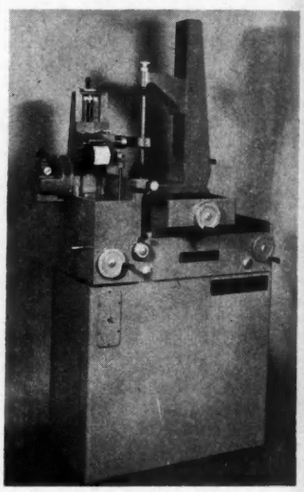
PROFILED components can be polished automatically in the Hammond CFT40 machine.

The machine, which has a standard table measuring 40 in by 30 in, is designed to deal with batch production of comparatively small quantities, or for long awkward shaped workpieces. The component is mounted on a quick-action jig which has a sprocket chain fixed to it following the contours of the component. This chain is engaged by a sprocket wheel on the worktable, being held against it by a pressure roller running on the inside of the jig. The jig is thus made to pass the component under the polishing head always presenting the work at the correct angle.

The sprocket is driven by a $\frac{1}{3}$ hp variable speed motor. A heavy polishing head with a 16 in diameter by 5 in mop, and a light polishing head with a 12 in diameter by $3\frac{1}{2}$ in mop are available. Both are universally adjustable to any angle and in addition floating heads can be provided for "hill and dale" work. A liquid compo spray gun is mounted to supply the compo through an aperture in the mop guard. The supply can be either automatically controlled using a pneumatic system and timing cams, or it can be controlled by a foot switch. *B. O. Morris Limited, Morrisflex Works, Briton Road, Coventry.*

GEAR TESTER

Involute and Helix Angles



BOTH involute and helix angles can be measured on the new No. 18 series machines.

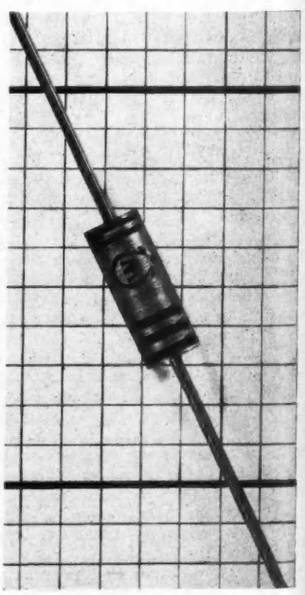
Spur and helical gears up to 18 in base circle diameter can be accommodated and when the centre locating column is in position gears up to 12 in diameter and 18 in between centres can be admitted.

There are two main models in the series. The standard machine is equipped with a mechanical recorder having a magnification of 500 : 1 with a ratio of graph to slide movement of between 1 : 1 and 3 : 1. Model 18T incorporates a Talymin side acting gauge head with electrolinear recorder equipment giving magnifications from × 100 to × 5,000. Both machines will give accurate recordings of variations of the order of 0·0001 in.

These machines use the individual base disc principle for involute measuring. Thus there is no setting of a base circle diameter or any need for mechanical linkage, as with a master disc or cam. Individual discs are relatively simple to manufacture and give positive setting with maximum accuracy. *David Brown Industries Limited, Tool Division, Park Works, Huddersfield.*

OXIDE RESISTORS

Miniature Size



A NEW miniature size range of Metox oxide resistors is now on the market.

The range comprises three ratings for $\frac{1}{2}$, 1 and 2 W with values from 47 ohm to 270 kilohms. Each rating is available with either 5 or 7 per cent "total excursion" or 5 and 10 per cent selection tolerance. The total excursion concept is the preferred type.

Chief claims for units include high power dissipation for small size; high protection given by moulded jacket; total excursion (that is maximum deviation from the nominal resistance value) specified for a period of 3 years continuous operation at full load. The diameter of the moulded case type is 0·307 in for the 2 W rated size and 0·145 in for the $\frac{1}{2}$ W model. Corresponding lengths are 0·680 in and 0·375 in. There is $1\frac{1}{2}$ in of 20 swg wire lead at each end of the resistor. Surface temperature rise of the $\frac{1}{2}$ W size is 50° C maximum and 100° C maximum for the 2 W rating. *Welwyn Electric Limited, Bedlington, Northumberland.*

WELDING SHIELD

With Hard Hat

THE COMBINATION of a welding face shield with a hard hat offers safety to welders working in shipyards and construction sites or wherever there is danger from falling objects.

In the "Pulsafe" combination the welding shield is attached to the hard hat by means of a patented recessed sliding block which is locked in place by means of a spring loaded catch. It is claimed that this is simple to operate. To remove the shield all that is needed is to push the spring clip back with the thumb and slide the shield clear. To fit the shield on the hat it is simply slid in place when the catch automatically locks.

Provision has been made for the shield to be swivelled up and over the hat so that inspection of the work is made easy without removal of either hat or shield. There is a ratchet mechanism that allows the most comfortable position of the shield to be chosen. Removal of the shield on completion of the welding operation still leaves the

operator with the protection of the hard hat.

The hat is made in moulded plastic and has an adjustable head harness and chin strap. The shield is available in either moulded vulcanised fibre or glass fibre, and is fitted with a flip-up front which allows the operator to chip or weld without the necessity of having to raise the whole shield. *Safety Products Limited, Holmethorpe Avenue, Redhill, Surrey.*

ELECTRODE HOLDER

Heat Shielded

A HANDLE that remains cool even during very heavy welding is one of the features of the Terrier 600 electrode holder.

Electrodes up to $\frac{1}{16}$ in diameter can be accommodated and currents up to 600 A used. The welding cable is connected direct to the head of the holder instead of running through the handle in the more usual way. The operator's hand is protected from any heat in the cable by a deflecting aluminium painted metal shield under which the cable is housed in asbestos on its way to the head, giving further heat insulation. As a result there is only a small section of the head that has to carry the welding current so that the holder has very little chance of heating up.

Other advantages claimed apart from the comfort during long runs are that time is saved and that the holder has a long life before any replacements are required. It is particularly applicable to the more complicated fabrications where heavy gauge electrodes are used and the

welding operations take some time with continuous working of high currents. *Interlas Limited, 9 Church Street, Ampthill, Bedford.*

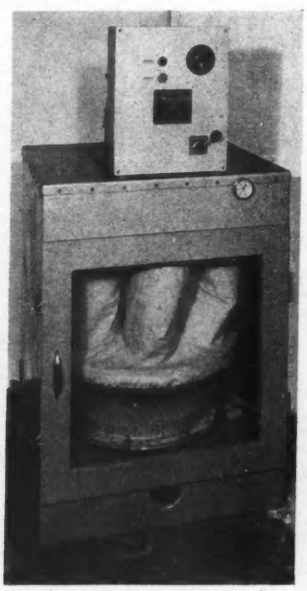
DRIER

Fluidised Bed

GRANULAR materials can be batch dried very quickly in a fluidised bed machine.

Four standard sizes are made with bowls of 0·3, 0·8, 1·6 and 3·2 cu. ft. capacity. In the two smaller machines the bowl is placed in the drier as shown, but in the larger ones it is mounted on legs and castors.

The drier consists of a steel case with a motor driven fan (ranging from 1 to 10 hp), a heater unit (ranging from 5 to 62 kW), and on the larger sizes an intake filter. A door with a viewing port is at the front. The material is placed in the plastic bowl and covered by a bag filter to collect fines. The fan and heat are switched on and the hot air drawn through the material. The temperature is regulated by a thermostat and the quantity of air kept so that the material is maintained in the fluidised state. Drying times are greatly reduced—from 12 hours at 70° C to 40 min at 40° C in one particular case. *Apex Construction Limited, 15 Soho Square, London, W1.*



PACKAGED DEHUMIDIFIERS

For Large Volumes

FULLY automatic control of the relative humidity of air down to 30 per cent is now possible with the new Hygro-Robot technique.

Volumes up to 100,000 cu. ft can be controlled by the electrically operated Hygro-Robots at negligible cost. Apart from the low relative humidity values obtained, the second outstanding feature is that the units will operate satisfactorily even in completely unheated areas. The range of operation—according to model—is from 14° F to 104° F. No ducting or ancillary equipment is required and no chemicals are used.

The units are equipped with hermetically-sealed high-performance oil-cooled compressors and, as there are no external loose connections or parts, no maintenance is required. The maximum water extraction rate in 24 hours (depending on emperature and humidity) varies according to model from 8 gallons to 17 gallons.

The lower temperature models are equipped with automatic defrosting mechanisms and are ideally suited for

protection against the condensation that takes place during the weekend shut-down of central heating. The units should find a special application in punch-card and computer rooms, cargo holds, cold stores and for quick and safe drying of new buildings. *British Sarozal Limited, 22 Berners Street, London, W1.*

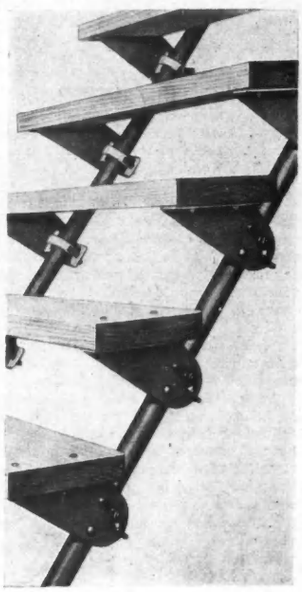
STAIR BRACKETS

For Scaffolding

BRACKETS for fixing stair treads to tubular scaffolding make for greater safety and easier access.

Both fixed and adjustable angle types are available, the latter being illustrated. The fixed angle version gives a stringer angle of 38° which is the one used for normal stairway requirements. The adjustable angle type has a range from 30° to 90° and has been produced to overcome the problem of erecting stairways in constricted areas by allowing the angle of the stringers to be chosen to suit the space available.

Both models are supplied for right and left hand use, and are marked accordingly for quick identification. They are finished in black, and all threaded parts are sheradised for rust prevention. They can be supplied completely sheradised if required. The brackets or couplers can be used for either permanent or temporary work and are available for hire as well as by purchase. *Scaffolding (Great Britain) Limited, Willow Lane, Mitcham, Surrey.*



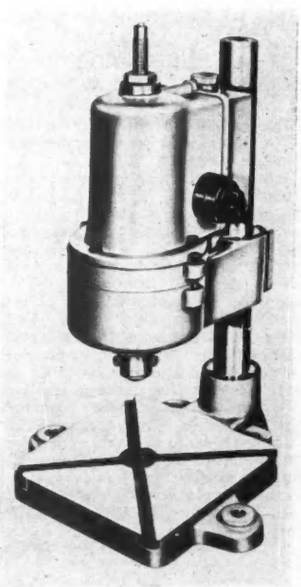
BENCH PRESS

Electromagnetic

A CYCLING rate up to 200 strokes per minute is obtainable with the IMR bench press.

The machine is solenoid operated with a maximum capacity of 3½ tons. The stroke rate can be regulated down to 20 per minute or single stroking can be performed. The impact force is infinitely variable from 7,500 lb to about 650 lb. The length of stroke is 2¼ in and daylight, table to ram, is 10½ in. The table measures 10 in by 10 in and the head can be supplied as a separate unit for special mounting either vertically or horizontally.

The standard machine is intended to operate from 230-250 volt mains, 50 cycles, the input current being 5A. A rectifier is built-in. Control can be by push button or pedal. The ease of adjusting the impact load and the rapidity with which tools can be set up make it suitable for a wide variety of operations on light metal, leather, plastics or cardboard. *H. G. Stevens Company Limited, 16 Coverdale Road, London, NW2.*



Physical Exhibition

London, 16-20 January, 1961

As a result of the recent amalgamation of the Institute of Physics and the Physical Society, the Physical Society Exhibition of Scientific Instruments and Apparatus will be known in future as the Annual Exhibition of the Institute of Physics and the Physical Society. Similarly to last year, the exhibition is being held at the halls of the Royal Horticultural Society, Westminster, W1, and will be open to the public from 2 p.m. to 7 p.m. on 16 January and from 10 a.m. to 7 p.m. on the other days, with an extension to 9 p.m. on 17 January and early closing at 1 p.m. on 20 January.

Discourses are to be given on Tuesday, Wednesday, and Thursday at 5.45 p.m. and as usual the exhibition will be the great annual meeting point for physicists and their friends where all the latest developments will be discussed and the latest ideas exchanged.

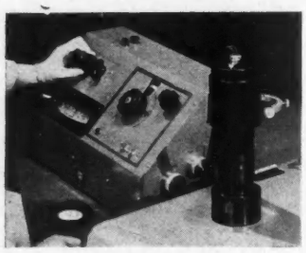
BALL SURFACE TESTER

AN ATTACHMENT for use with the Talysurf 3 instrument permits the surface roughness of balls 1 mm in diameter to be measured to half-millionths of an inch.

The attachment consists of a stationary pick-up unit in which a stylus is mounted underneath a conical seating. The ball to be tested is placed on the seating where it is then rotated by a friction drive, controlled from the Talysurf gearbox, to give the same velocity as that of the normal traverse. This permits both graphs and average readings to be obtained. The range of balls catered for is from 1 mm to 1 in. Graph readings are recorded with magnifications up to × 50,000. *Taylor, Taylor and Hobson Limited, Stoughton Street, Leicester.*

COLOUR METER

Surfaces or Transparencies



THE COLOURMETER J 40 measures surface colour in terms of three standard stimuli and uses the CIE notation.

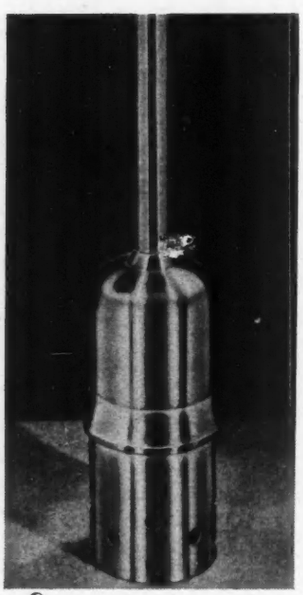
Three standards of reference are available for use with the instrument: a magnesium oxide surface as an absolute reference; a calibrated durable white secondary standard; and a set of coloured standards. These enable the instrument to be used on a very wide range of materials including cartons, ceramics, fabrics, foodstuffs, leather, inks, and tiles. A 1 per cent change in tristimulus value produces a galvanometer deflection of about 5 divisions.

An accuracy of ± 0·005 is obtainable in the coefficients over a wide region in the colour field bounded approximately by the locus of Munsell chroma 10. For difference measurements discrimination in chromacity is about ± 0·0005 over the same region. This approaches the discrimination obtained by spectrophotometry. Tristimulus values can be read directly from the scale of the potentiometer.

The test sample is placed on the top of the detector unit which can be moved to a distance of 1 meter from the control unit to reach awkward surfaces. The reflected light from the sample is received by a ring shaped barrier-layer cell. The galvanometer is used as a null indicator and a calibrated potentiometer controls the balancing current. There is also provision for direct reading of galvanometer deflections for rapid measurements at lower accuracy. Standard illuminant C of the CIE is used and a filter is available for conversion to illuminant B. *Hilger and Watts Limited, 98 St. Pancras Way, Camden Road, London, W1.*

pH ELECTRODE

Immersion Type



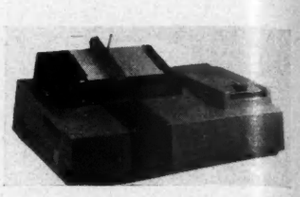
THE pH electrode unit type 11460 illustrated is for use in open channels, tanks or troughs.

The unit is designed to give the easiest maintenance. The electrodes are mounted on a stainless steel base plate and sealed with glands, the lower end being shrouded by a protective cage which is also fabricated from stainless steel. Electrical connections to the electrode are made inside a protective housing which forms a completely watertight seal around the base plate.

Housing and extension tubes of various lengths are also in stainless steel, and clamping arrangements are remote from the liquid. The electrical leads are incorporated in a multicore cable and completely sealed by a waterproof gland at the top of the assembly, which also carries a potassium chloride reservoir. The reservoir supplies the preference electrode and ensures a positive head to prevent electrode contamination. *W. G. Pye and Company Limited, Granta Works, Cambridge.*

SPECTRO-PHOTOMETER

Wide Scanning Range



THE SP200 is a new infra red spectrophotometer designed essentially for routine analysis.

The scope of the instrument is wide and it is intended for use by those who do not have access to a very large instrument. Spectra are presented on charts which are foolscap in size and which are ruled with scales linear in wave number and transmittance. The recorder is of the flat bed type and the carriage is drawn past the ball point pen. The pen pressure is sufficient to produce carbon copies—a useful addition for laboratory work.

The scan, which covers the range from 650 to 5,000 cm^{-1}, is completed in ten minutes and only a few seconds are needed for resetting. Control under normal conditions is exercised by one small lever. The scan may be started and stopped at any point.

The photometer is the double beam null balancing type with a Nernst filament as the source. The radiation enters the monochromater at a frequency of ten cycles per second. The slits are programmed to pass a level frequency of energy which is constant over the range. The level may be varied in cases where, for example, there is strong absorption in the reference beam, and the energy of the system restored to the normal level. A 60° rock salt prism is used as the dispersing element and the radiation is finally focused on to the Golay detector whose advantages include a large receiving area and a uniform response throughout the wavenumber range. The electronics are mounted on three small chassis, and a monitoring system is provided. The SP200 is equipped with standard type slide mounts and will accept a majority of the cells now in use. Fixed frequency scanning can also be undertaken. *Unicam Instruments Limited, Arbury Works, Cambridge.*

VOLTMETER

Suppressed Zero

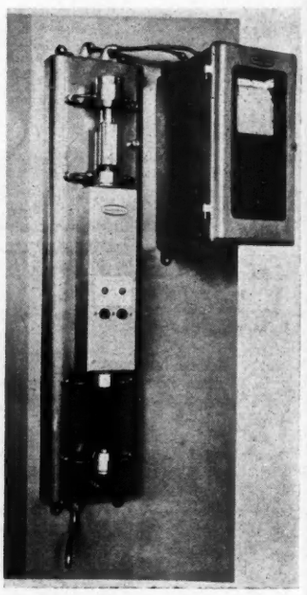
ABSOLUTE voltages up to 500V dc can be measured on a new suppressed zero meter model TF 1377.

The instrument operates on the potentiometric slide-back mode with the source voltage backed off against a potentiometer controlled internal supply using the centre zero of the meter as the null indicator. The absolute voltage is indicated by the digital read-out of the potentiometer, and subsequent variations are shown on the meter. Changes as low as 1 mV in the source can be measured without the need for external batteries or backing-off a standing voltage. In the differential mode the potentiometer is switched out of circuit and small unknown voltages are indicated directly on the meter, the range then being from ±1 mV to ±50 V.

The instrument allows rapid and accurate measurement of a wide range of dc voltages in the laboratory, production line, or field. The precision incremental measurement system is said to be particularly suitable for many applications such as regulation and stability tests on dc sources, coefficient measurements, strain gauge tests, and generater regulation. Rectifier probes are available to extend the range of usefulness to audio and rf measurement. *Marconi Instruments Limited, St. Albans, Hertfordshire.*

WATER MONITOR

Radioisotopes



HIGH sensitivity is one of the features of the water radioactivity monitor type ND 2151.

The instrument will detect a specific activity well below the maximum permissible level for drinking water. The equipment consists of a sampling unit and an indicating unit. The former contains a Geiger-Muller tube surrounded by a bed of ion exchange resin. The indicating unit records continuously the mean counting rate, and if required actuates an alarm. Transistors are used in the circuits for stability.

Sampling is normally carried out at a rate of 20 gallons per week, after which the resin is replaced. With the lead shield the background count should not exceed 20 per minute. The recorder is the graphic type scaled 0 to 50 cpm with a range from 0 to 1 mA. Full scale output of 50 cpm corresponds to 200 $\mu\mu c$ of strontium 90. The count is averaged over a period of about 10 minutes. *Elliott-Nucleonics Limited, Century Works, Connington Road, London, SE13.*

Nuclear Superheating

STEAM cycle efficiency may be raised by increasing the steam temperature while keeping the steam pressure and plant size constant. The attractions of superheating have been widely exploited in the development of the conventional fossil fuelled power stations, and the savings in capital and operating costs from use of superheated steam rather than saturated steam are of comparable importance to the saving in fuel cost due to the increased cycle efficiency.

Economic Attractions

In pure boiling-water reactors, as the operating pressure is raised to achieve high power density with low circulation rates, improved stability, and high cycle efficiency, the turbine required to utilise the saturated steam becomes increasingly complicated. Extraction stages are required to remove moisture from the steam as it expands through the turbine, since accumulation of moisture in the steam reduces the turbine efficiency. If this content is not kept below 12 per cent by weight, the corrosion-erosion of the blades becomes excessive. It is also necessary to have high quality steam in the superheater to diminish the amount of corrosion or fission product deposition on the superheater fuel jackets, and to reduce the amount of radioactive carry-over to the turbine from crud bursts released from the superheater fuel jackets. For a given power plant the steam flow rate is less with superheated steam than with saturated steam, thus reducing the size of a number of components and thereby reducing the plant capital cost. It follows that the reasons for the attractiveness of nuclear superheating are basically economic.

Variations on a Theme

Among water-cooled reactors with superheaters is the graphite or heavy-water moderated pressure-tube type superheating reactor, in which the light water coolant makes a boiling pass through the core and the steam then returns through one or more passes for superheating. Alternatively, one reactor may be used for boiling the water and a second for superheating the water. Although the latter is easier to control, it is only economic in the large sizes—1,000 MW(t) or greater. Another type is the more familiar boiling-water concept, in which the superheating may be carried out by one of two methods: either in the same reactor, called the "integral" type, or in a separate reactor, called the "non-integral" type. Again it is considered that the latter would only be economic in a large power plant where the large superheating reactor receives steam from several large boiling reactors. The integral boiling superheating reactors are more complicated, chiefly because the independent control is lost between the two states, owing to the two regions being in the same vessel. The fact that they may be built in more modest sizes is the main advantage for the present development of this type.

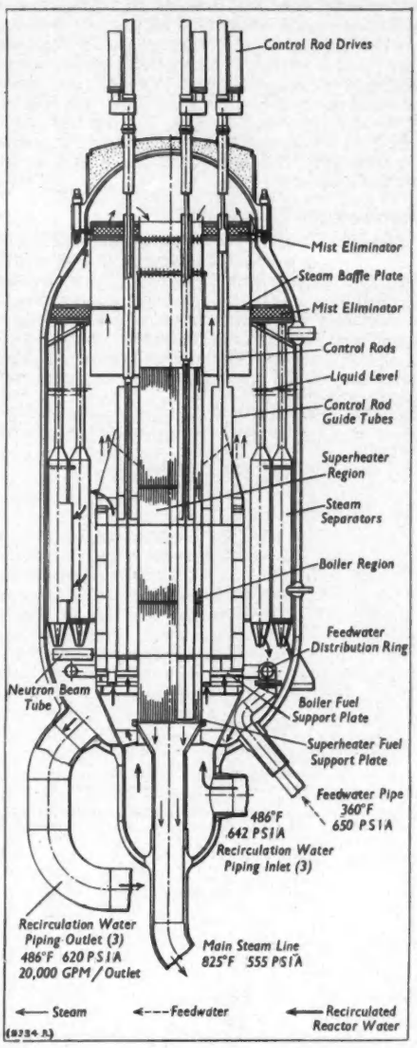


Fig. 3 (above) Vertical section through the Pathfinder reactor, showing a central superheating zone and the circulating pattern.

Positive Reactivity Effect on Flooding

Additional design problems encountered with the integral concept include: the location of the superheat zone, which may be placed in a central or peripheral position. The central zone is in the high flux and main heat generation region of the core, and therefore requires a smaller volume for the given power. Also the superheater needs less loading, has a flatter power distribution curve and reduces the overall reactor maximum-to-average power ratio. It has relatively higher heat fluxes and fuel temperatures. However, in a practical design the central superheater usually has the disadvantage of a higher reactivity value on flooding where it has been calculated to give a positive reactivity effect of 0·9 per cent. The peripheral position is safer on flooding, giving a calculated positive reactivity coefficient of 0·6 per cent, and being in the low-flux and heat region of the core—the heat flux and fuel temperature will be lower and the natural low power density is more consistent with the poor heat transfer coefficient of steam. The radial power distribution is given for the central and peripheral loading in Figs. 1 and 2.

Other problems include shutting-down of the superheater; the material properties required by the superheater fuel; the possible positive reactivity addition on flooding; and the radioactive fission-product carry-over into the steam from a ruptured superheat fuel element.

Three USAEC Projects

The United States Atomic Energy Commission has three small reactor plants under construction or authorised: BORAX V at Arco; the Pathfinder at the Argonne National Laboratory; and the BONUS reactor at Puerto Rico. A vertical section of the Pathfinder appears in Fig. 3. Each of these projects employs the integral-superheat direct-cycle concept with boiling water and a nuclear superheat region in a single vessel. The resulting superheated steam is transported directly to the turbine. In BORAX V, the superheated region may be placed in the central or peripheral position ("A Nuclear Superheating Reactor—BORAX V" by R. E. Rice and M. Norvick).

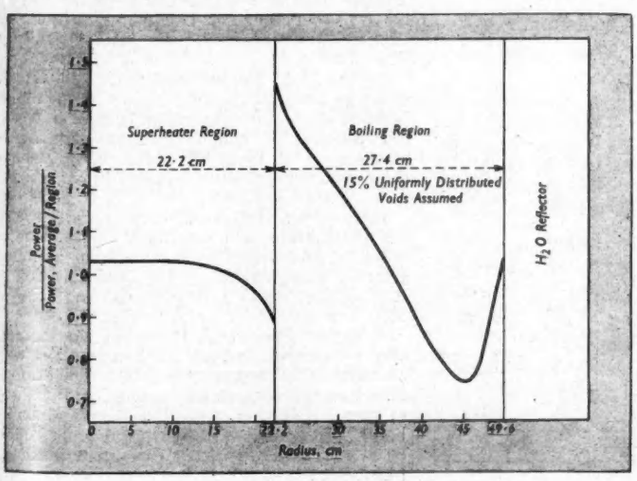
Fossil Fuel Superheating

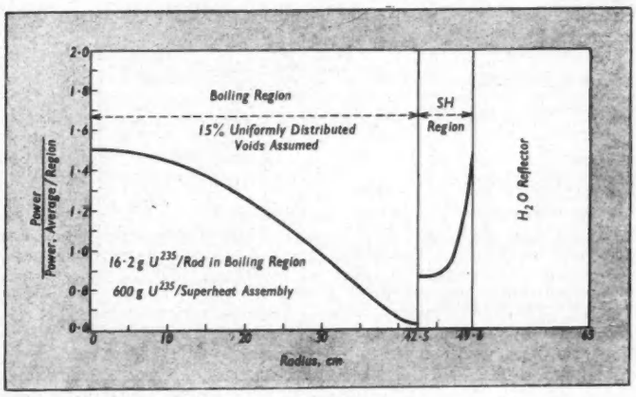
Two small fossil fired superheat plants have also been authorised. These are the Elk River Reactor, and the Small Pressurised Water Reactor (SPWR). The vital statistics of four of these reactors are given in the accompanying table. In addition to the above programme there are a number of smaller projects designed to look into the specific problems.

Superheater Fuel Elements

The success of the nuclear superheat concept weighs heavily upon the development of a satisfactory superheater fuel element. A major design limitation is the maximum allowable fuel-cladding surface temperature, which is

Calculated radial power distribution for a central superheated zone shown in Fig. 1 (left) and for a peripheral superheated zone in Fig. 2 (below).





currently believed to be approximately 1,250° F for stainless steels under steady-state operation. Neutron economy considerations require that the amount of stainless steel is kept to a minimum. Much work remains to be done to determine the type and geometry that will be the most satisfactory for the superheater element. Some of the configurat ons that have been considered are: concentric stainless-steel uranium-dioxide cermet fuel tubes in a double-wall stainless-steel static steam insulating tube; annular uranium-dioxide pellets clad inside and out with stainless-steel tubes and contained in a double-wall tube; individual oxide rods clad with stainless steel in an insulating tube; and clusters of such rods in an insulating tube. In the three small reactor plants mentioned earlier it is seen from the table that the configuration of the fuel element is different in each case.

Process Tubes

Process tubes or flow channels are required as a barrier between the superheated steam and moderator in the superheat region of all reactors using thermal neutrons. In the reactors under construction the process tube is of double-walled construction. During operation the space between the two stainless-steel tubes is filled with an insulation barrier of stagnant steam. A double-walled process tube of materials with lower cross-section is being developed. The tubes are made up of laminated stainless steel and Zircaloy-2 with a thin layer of stainless steel on the outer surface for corrosion resistance. This design has been simplified in several conceptual design studies, and eliminated altogether in the mixed spectrum reactor design.

Development and Research Results

Design studies and economic evaluations have established certain criteria (taken from " USAEC Superheat Programme," by C. A. Pursel). In the case of a 200 MW(e) integral boiler—superheater reactor it has been found that optimum steam conditions at the turbine throttle are 900° F and 1,000 lb per sq. in. The fuel cycle cost differential of a peripheral location of the superheat region is a maximum of 0·1 mill per kW hour over either a central or annular location. The optimisation of the fuel lattice in any configuration of the regions can attribute 0·9 mill per kW hour. The flooding coefficient is determined by the superheater fuel lattice and is independent of the superheater location. In a separate boiler superheater reactor system the fuel cycle economics are chiefly determined by the fuel costs of the boiling reactor, since less than one third of the thermal energy is contributed by the superheating reactor. Various independent tests have shown that there is no increase in the quantity of free hydrogen and oxygen due to radiolytic decomposition within the superheater, and 410 stainless steel has been found the least affected by the reactivity.

Russian Venture

The Soviet Union is also reported to have a superheating reactor (ENGNG., vol. 184, 1957, p. 283). Designated " Project 2," the reactor is graphite moderated and cooled by water and steam; some core channels will be used to superheat the steam in the primary circuit to approximately 540° C at 160 atmospheres. The secondary circuit pressure is 90 atmospheres and temperature 500° C.

TABLE:—*Superheat Reactor Plants under Construction in the United States*

Name	Elk River Reactor	BORAX V	Pathfinder Reactor	BONUS
Location	Elk River, Minnesota	Arco, Idaho	Sioux Falls, South Dakota	Puerto Rico
Prime contractor	Allis-Chalmers Manufacturing Co. (AC)	Argonne National Laboratory (ANL)	Allis-Chalmers Manufacturing Co. (AC)	General Nuclear Engineering Corporation (GNEC)
Function	Electric power	Power experiment	Electric power	Electric power
Reactor type	Thermal neutron, H_2O moderated	Thermal neutron H_2O moderated	Thermal neutron H_2O moderated	Thermal neutron, H_2O moderated
Reactor system	Boiling water reactor, fossil fired superheater	Integral boiling-superheating reactor	Integral boiling-superheating reactor	Integral boiling-superheating reactor
Location of superheater region	—	Central or peripheral	Central	Peripheral
Location of boiling region	Entire core	Peripheral or central	Peripheral	Central
Reach full power	February, 1961	July, 1961	October, 1962	December, 1962
Electric power, gross (MW)	23	3·5	66	17·3
Gross heat output (MW)	73	35·7	203	50·0
Nominal operating pressure, reactor (lb per sq. in)	935	600	600	900
Turbine throttle steam pressure (psig)	600	350	540	850
Saturated steam temperature (°F)	538 (reactor)	489	489	534
Superheated steam temperature (°F)	825	850	825	900
Gross cycle efficiency (per cent)	31·6	—	32·5	34·6
Maximum fuel centreline temperature, boiling region, (°F)	4,500	2,000	4,400	4,400
Maximum fuel cladding temperature, superheat region, (°F)	—	1,115	1,250	1,140
Total reactor steam flow (lb per hr)	258,000	88,800	615,000	152,000

	Boiler	*Superheater*	*Boiler*	*Superheater*	*Boiler*	*Superheater*	*Boiler*	*Superheater*
Effective outside core diameter (ft)	5·0	—	3·25	Central 1·0	6·0	2·5	3·34	4·71
Core height (ft)	5·0	—	2·0	2·0	6·0	6·0	4·54	4·55
Structural material (active core)	Zircaloy 2	—	Aluminium (X8001)	Stainless steel	Zircaloy 2	Stainless steel	Zircaloy 2	Stainless steel
Fuel type	Rod	—	Rod	Plate	Rod	Double tubular	Rod	Rod
Fuel material	UO_2-ThO_2	—	UO_2	UO_2-SS cermet	UO_2	UO_2-SS cermet	UO_2	UO_2
Fuel enrichment (per cent)	4·3 U-235	—	5,10 and 20	93	1·85	93	1·85 and 0·71	3·5
Cladding material	SS	—	304 SS	304 SS	Zr-2	316 L. SS	Zr-2	316 SS
Control rod shape	Cruciform	—	Cruciform and "T" blades	Cruciform and "T" blades	Cruciform	Annular	Cruciform	Slab
Control rod material (percentage weight of boron in stainless steel)	2	—	2	2	2	2	2	2
Control rod entry-in core	Top	—	Bottom and top	Bottom and top	Top	Top	Top	Top
No. of steam passes in core	—	—	1		2		4	

SS = Stainless steel; UO_2 = Uranium dioxide; Zr-2 = Zircaloy 2.

Notes and News

University Reactors

The first lecture sponsored by the Institution of Nuclear Engineers was given by Dr. N. S. Grassam of Southampton University in London on 9 December, 1960, entitled " Nuclear Reactors in Universities." Dr. Grassam said that university reactors were not necessarily vital for introductory courses into nuclear science, although the student should see reactors and have experience of nuclear measuring techniques. A grasp of these techniques could be provided by a reactor simulator. The chief reward would come from advanced teaching courses embracing research. It had been said that universities should coordinate their programmes to make use of Atomic Energy Authority reactors, but Dr. Grassam put a strong case against this and pointed out the fallacies. Basically, these were the difficulty of coordinating the relatively small programme of a student with the major experimental programme of the Authority. The close proximity of the reactor to the university afforded the right conditions for independent and unbiassed thoughts to mature, and would also encourage and provide useful facilities for other branches of science within the university.

American Experience

The success of the university reactor may be said to rest in its research potential. If this potential is to be achieved, it is necessary to have a sufficiently high power rating, and a maximum flux of 10^{11} to 10^{12} neutrons per sq. cm per second is usually considered suitable for most university needs. A rating at this level obviates the need for excessive expenditure on reactor shielding which becomes a more significant factor as higher fluxes are reached. It is interesting to note that the United States Atomic Energy Commission has been very generous in providing funds for university teaching reactors, of which there are now over thirty, but within the last few months the Commission has announced that it has decided not to finance any more teaching reactors. It must be admitted that these were usually of very low fluxes producing power of the order of 10 watts and served little purpose for research. Also, for the present, the National Science Foundation does not intend to finance any more reactors in the range of 10 to 100 watts. About a dozen of these are being or have been built in the United States. However, higher powered reactors are not being discouraged.

British Compromise

A reasonable compromise for the British Government would be to provide a limited number of low powered reactors, so that first-class teaching and research may be conducted and a steady supply of well taught and research-minded nuclear engineers created.

Reports Received

Reduction in Fall-Out: Concentration in air and rain of long-lived fission-product activity reached maximum values in 1959 and have significantly decreased over the United Kingdom. (" Radio-Active Fall-Out in Air and Rain," by D. H. Pierson *et al.* AERE-R 3358.)

Uranium Dioxide Oxidation: It is indicated that the oxidation of uranium oxide is brought about mainly by oxygen produced during the radiolytic decomposition of the water vapour. Oxidation rates can be calculated and it is considered that the oxidation rate of pellets in defected cans in a steam-cooled reactor will be low. (" Oxidation of Uranium-Dioxide by Water Vapour under Reactor Irradiation," by B. R. Harder *et al.* AERE-M 725.)

Helium Field Measurements: Using a Janak type gas chromatograph, it has been found possible to measure the helium content down to 0·1 per cent in helium-hydrogen-air-methane-mixtures. (" A Field Method for the Measurement of Helium in Natural Gases," by M. Wilkins *et al.* AERE-R 3244.)

Radioiodine: The complicated procedure for the preparation and determination of Radioiodine in solutions of nitric or hydrochloric acid solutions is explained. (" The Determination of Radioiodine," by G. J. Hunter *et al.* AERE-AM 64.)

Strontium Review: A review of the medical effects that strontium will produce together with an extensive bibliography is given. The importance that this element has assumed in the study of tumor induction, and physiology and metabolism of the bone is also included in the report by K. Williams entitled " Strontium Studies. (AERE-R 3423.)

Companies

Preparing for Future Car Industry Demands

THE three major considerations in the overhaul of the capital expenditure programme of the ASSOCIATED ENGINEERING Group are worth setting down in full.

The full programme is for more than £12,500,000 and the considerations borne in mind were:

Heavy additional demands likely to come from the main customers in the motor industry when their published expansion projects come into operation,

Need for an accelerated programme of modernisation of some sections of the existing factories. This has become more pressing as a result of the programme of rationalisation now being carried out in the Engine Components Division,

Need to expand the group's manufacturing and distributing interests in the Commonwealth and Europe.

In the financial year which ended last September the Associated Engineering group increased substantially the turnover and the profits, working at a high level throughout the year, apart from a slight levelling off in the last month as the effects of the reduced production in the motor industry were felt.

Consolidated net profits before tax were £3,670,063, which was 24 per cent up on the previous year. Rising costs, mainly attributed to the introduction of the shorter working week, were beginning to effect profit margins in the latter half of the year, despite the generally high level of activity.

The principal projects in the development programme are a new foundry and piston ring plant at Sunderland to enlarge the capacity of HEPWORTH AND GRANDAGE, a new plant at Lydney for casting and making sand foundry products at the BRITISH PISTON RING Company and for major extensions for diesel engine products at WELLWORTHY Limited. Increasing the capacity of the presswork and plating plants of COVENTRY RADIATOR and PRESSWORK Limited will involve an outlay of £1,500,000.

Overseas the main proposals are for a new foundry and machine shop in Italy for the subsidiary PISTONE AE BORGO and for the consolidation in a new factory of the piston, cylinder liner and foundry operations of LAUF-LUMENITE (PTY) Limited, South Africa.

The Associated Engineering board believe that although the present short-term outlook is one of somewhat reduced activity the prosecution of this policy of heavy capital investment is probably even more vital now than ever before.

The AE chairman, Mr. Henry R. Moore, recalls in his review the announcement last year that AE had decided to produce some of its engine components in the European Common Market. A start has been made on this by the purchase of PISTONE BORGO, Italy, and the French companies SOCIETE E. DEMOLIN, at Ivry-sur-Seine, Paris, and S.A.F. DE PISTONE BORGO, which was for many years an associate of Pistone Borgo of Turin.

Further afield, in the Commonwealth, the associated companies in India, Australia and New Zealand have been making satisfactory progress. Despite the political situation of South Africa, the wholly owned subsidiaries there, Lauf-Lumenite (Pty) and ENGINEERING REPLACEMENTS HOLDINGS Limited have raised their profits.

The Ubiquitous Leonides Engine

In a time when the jet gets all the attention in the aviation field it is worth noting that the famous Alvis Leonides piston engine is in service in some 33 countries and that these engines are about to go into service with the Royal Malayan Air Force, the Royal Jordan Air Force and the Sudan Air Force among others.

So many Leonides engines are at work around the world that the business of overhaul and spares is a useful part of the activities of the ALVIS Company. An interesting operation the company has been carrying out is the conversion of earlier marks of engines to a higher-powered long-stroke type for military and commercial operators.

Reviewing the activities of the company in the past year, Mr. J. J. Parkes, the chairman, says the propeller driven, piston engined aircraft still has no exact counterpart in the turbine engined field for operations at comparatively low altitudes and where flexibility of performance is essential. This creates an opportunity of which Alvis have been able to take useful advantage.

The Royal Air Force and the South African Air Force have placed repeat orders for Alvis fire crash tenders and further development work on the improvement of mobility and ease of handling is being carried out. In a related sector of transport, extensive trials have been going on through the year on the Stalwart, a multi-wheeled cross-country cargo carrier which has been designed both for civil and military use.

It is not altogether surprising, the Alvis 3 litre car being such a worthy model, that the recession in the car industry does not find one of its minor chapters being written here. Demand for the car has been maintained and the number of orders taken at the Motor Show is described as " very gratifying."

David Brown Regroup for Closer Control

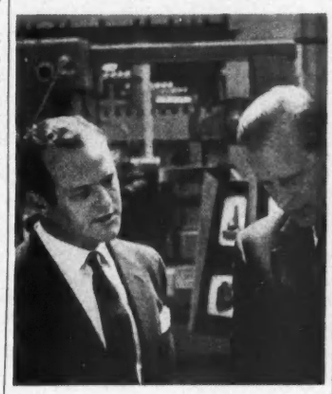
Careful control of overheads and an 11 per cent increase in the activity of the group last year enabled the DAVID BROWN Corporation to overcome narrowing profit margins and reach the highest profits since 1955.

In his chairman's review, Mr. David Brown, describes some of the causes of the increasing costs. They include the indirect increase in wages brought about by last spring's reduction in the basic working week, at a time when the group was facing demand for further increases sufficient to considerably affect the labour costs. From April of this year the effects of the new National Graduated Pension Scheme will add £32,000 to the £162,000 which DB now contribute to the National Insurance Scheme.

Increased Orders

On top of these increasing labour charges must be counted rising power, fuel, transport and shipping rates. A more optimistic note is the very large increase in the number of orders the group has received since 1 July, 1960, over the same period of the previous year.

£540,000 was spent on new plant and equipment during 1960 and there is a commitment to spend another £450,000. Plant investment, prevention of inventory reduction due to the rising level of



orders, and the impact of taxation have made it impossible for the liquid position of the group's finances to be further improved. Thus, despite the high profit level compared with the previous year, no dividend has been recommended on the ordinary shares.

The profit for 1960 of the Corporation and its subsidiaries, before tax, was £756,492 (1959—£167,598). After profits tax, income tax and overseas tax last year's profits were reduced to £394,343. The balance carried forward at the end of the account was £2,403,095.

Outstanding among the year's developments was the introduction in the United States, and then to the world markets, of the range of David Brown Radicon worm reducers. The Radicon name, derived from radiation, convection and conduction, was first used in 1932 when the company introduced fully enclosed fan cooled worm gear units. Radicon evolution is traced back to 1902 and the development of right-angle worm drives in compact units with self-contained bearings. The launching of the new range, with exhibitions in London and Harrogate, came in the organisation's centenary year.

An important element of the company's long term research work is its cooperation with ELECTRIC AND MUSICAL INDUSTRIES ELECTRONICS Limited and the Mechanical Engineering Research Laboratory on the electronic operation and control of gear manufacturing machinery. Two important applications were shown at last year's International Machine Tool Exhibition, where one of the visitors, the Duke of Edinburgh, received some words of explanation from David Brown junior (inset).

The DB Tractor Division substantially increased the volume of its orders, benefiting from an upswing in the agricultural machinery market in many countries. Brazil and the United States were particular areas in which the division had a successful year.

A fresh regrouping of the manufacturing units has been decided upon with the aim of obtaining a closer control of operating expenses. Managers will be accepting more responsibility for the results of their individual plants. DAVID BROWN AND SONS (HUDDERSFIELD) Limited and DAVID BROWN TRACTORS Limited have been reestablished as separate units. The first will be responsible for gear, machine tool and foundry products; the second for tractor and farm machinery. ASTON MARTIN LAGONDA Limited have taken over the motor manufacturing previously carried on under DAVID BROWN INDUSTRIES Limited and also the operation of TICKFORD Limited. Each of these companies will control its own overseas subsidiaries.

Anniversary with Record Profits

Happily celebrating their fiftieth anniversary with the announcement of record profits are the YORKSHIRE COPPER WORKS (HOLDINGS) Limited.

YCW (Holdings) are joint owners with IMPERIAL CHEMICAL INDUSTRIES of YORKSHIRE IMPERIAL METALS, which was formed in January, 1958. At the time of setting up the new organisation YCW accepted a 20 per cent fall in profits. Now, two and a half years later, the position has been more than restored and the results are an improvement on the exceptionally good year of 1956.

Through all sections of the company the year up to the end of last July was a busy one, apart from quieter conditions at the plate works at Landore, Swansea. Output from the plate works is now rather better following an increase in demand.

An upswing in the demand for copper tubes, based largely on greater activity in house building, has assisted the other factories of the group. The alloy tube side, whose demand comes from shipbuilding, power stations and the oil industry, has stayed quiet. At home YIM continues the development of new plastics materials and is introducing new lines.

Yorkshire Imperial Metal's trading and manufacturing profit for the year increased from £2,335,572 to £2,754,824. Since price moves in copper, to which YIM is particularly sensitive, were not as favourable last year as during the previous twelve months, the improvements in manufacturing and trading are rather more than the figures alone show.

YIM has joined with IMPERIAL CHEMICAL INDUSTRIES OF AUSTRALIA AND NEW ZEALAND (ICIANZ) to establish a plant for the production of non-ferrous sheet, strip and tubes in New Zealand. ICIANZ will be the principal partner and public investment is to be invited.

In a further Australasian development, ICIANZ are to take a substantial minority interest in the Australian subsidiary of YIM—YORKSHIRE FITTINGS (AUSTRALIA) PTY Limited.

Associated Engineering's Trading Results Before Tax

	1959	1960
Six months to 31 March	1,148,000	1,963,000
Six months to 30 September	1,807,000	1,707,000
	£2,955,000	£3,670,000

The Cooke Troughton and Simms M15 Series Microscope

To make a precision instrument at lower cost without sacrificing quality, mass production methods were tried with conspicuous success.

WHEN mass production techniques are applied to a seemingly unsuitable candidate, such as a microscope, startling results may be expected. A complete reappraisal of the design is first necessary in the light of the proposed new production methods—and most of what the resulting product owes to its predecessors will be indirect rather than direct, however successful the earlier models may have been. Such a product is the M 15 biological microscope, introduced during 1959 by Cooke Troughton and Simms of York, a company of the Vickers group.

The microscope is one of the scientist's basic tools, as the micrometer is one of the engineer's. But the microscope goes one better. By means of interchangeable attachments or "accessories" the microscope also becomes a tool of the engineer, whereas the micrometer is of little use to the scientist.

A microscope, like any optical instrument, demands a high degree of precision engineering skills. Accuracy of manufacture in both mechanical and optical components must be of a very high order. Cooke Troughton and Simms knew when they decided to introduce the M 15 that the extent of its success would depend almost entirely upon economics; in other words, how cheaply could it be made without sacrificing quality of the end product, the finished microscope? They decided to design the M 15 deliberately for production at the minimum cost, and hoped that the low price would sell enough to justify the mass production methods adopted. In fact, only the well-proven optical components were to be inherited from the then existing range, for reasons that this survey will show. Work study was introduced at the same time.

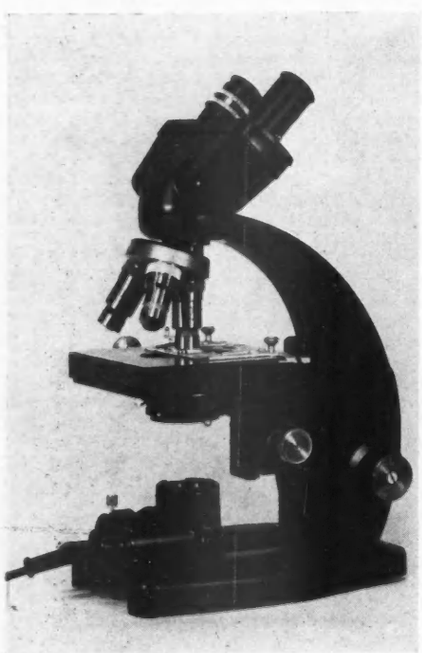


Fig. 1 The M15 in one of its standard forms with built-on illuminator.

The result of this bold approach, unsupported by any market research investigations, is that the M 15 in its simplest form sells for as little as £41 12*s*. Not surprisingly, it was such an immediate success that nearly 1,400 were sold during 1960, its first full year of production, compared with the 750 planned, and the firm were hard put to it to keep pace with demand.

Optical instruments generally do not lend themselves to mass production methods, since they are too dependent upon the human eye for the finer points of discrimination. However, Cooke Troughton and Simms had introduced certain semi-mass production techniques to meet the demands of the Second World War, and these were carried a stage further in the M 15 microscope by introducing line assembly. In respect of design, the most important contributions to low cost were the acceptance of simplified mechanical component design (in association with the introduction of automatic machine tools), and the use of pressure die castings for the main items.

Cooke Troughton and Simms Limited are precision optical instrument manufacturers of exceptionally long standing, whose origins can be traced back at least two and a half centuries. One of the early principals was a certain John Rowley, a maker of mathematical and astronomical instruments, who conducted his business in Fleet Street, London. In 1712 he made one of the first examples of an "Orrery," an instrument which represented the movement of the sun and planets in the form of a clockwork driven model contained in a cabinet. The Orrery is still used as the firm's trademark.

The company assumed its present name in 1922, when the assets of Troughton and Simms Limited of Charlton, London, were acquired by T. Cooke and Sons Limited of Buckingham Works, York. T. Cooke and Sons were a subsidiary of Vickers Limited, their interests having been acquired by Vickers during the First World War. In October, 1939, a new factory was opened on a 5½-acre rural site in Haxby Road, to the north of York, and this is now the headquarters of the company.

MICROSCOPES

Though microscopes had been made from time to time by their forefathers, Cooke Troughton and Simms built up their reputation over the years mainly on surveying equipment. Their first serious entry into microscopy took place in 1932 when they started production of the Vickers projection microscope. It had originally been developed by Vickers Limited at their Erith Works, and was well received by metallurgists generally.

As might be expected, World War II brought with it a tremendous expansion, and the firm's efforts were directed into two main channels. They had first to provide the armed forces with optical instruments in much larger numbers than hitherto; and second to develop precision equipment for industrial inspection and the maintenance of essential standards of accuracy.

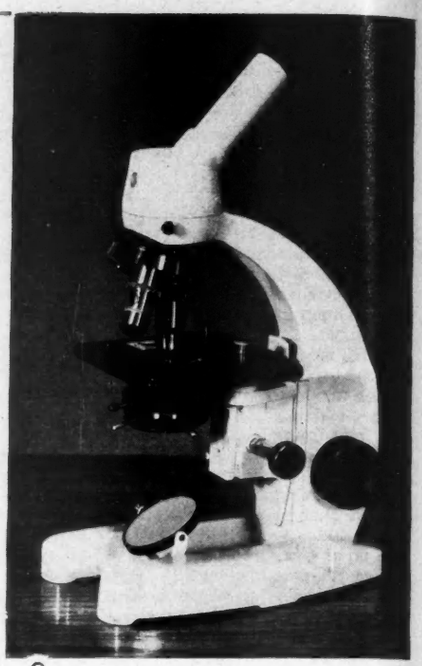


Fig. 2 One of the simple versions.

Toolmakers' and works measuring microscopes were among the instruments produced at this time, and it was then realised that after the war the introduction of a complete range of commercial microscopes would assist the company's return to peacetime conditions.

Unfortunately for the civilian side of the firm's activities, the establishment of NATO in 1949 necessitated a sudden increase in military production just at the time that most other engineering firms had recovered from the war and were beginning to reap the rewards of rapidly expanding civilian markets.

THE M 15 SERIES

Microscopes were made in some quantity during the immediate post-war years, but the effect of this sudden brake on the establishment of their commercial products is reflected in the rather belated "go-ahead" on the M 15, which was not given until August, 1958. Vigorous action on the part of the firm's executives and designers then followed. It resulted in rough sketches in September, 1958, being translated into the first production models exactly a year later—an astonishing achievement.

At first sight the M 15 Series may not appear to be so very different from its immediate predecessor, the M 25, which dates from about 1950. Redesigning a product with the primary aim of effecting greater economy in production is, after all, a fairly commonplace line of action to take in these days of increasing competition. But let us take a closer look at the M 15.

To begin with, the optical equipment industry generally is not one of recurring changes in fashion, or of rapid, revolutionary technical developments. Against this background the M 15 series microscope makes a far bigger impact. One of the main reasons for this seeming conservatism on the part of optical equipment manufacturers is the lengthy development necessary before any fundamental changes can be made to the optical system itself. To design from scratch the optical system for a new microscope, for example, takes many years by conventional methods. Using a computer will shorten this time considerably, and the firm have participated in supporting the recent

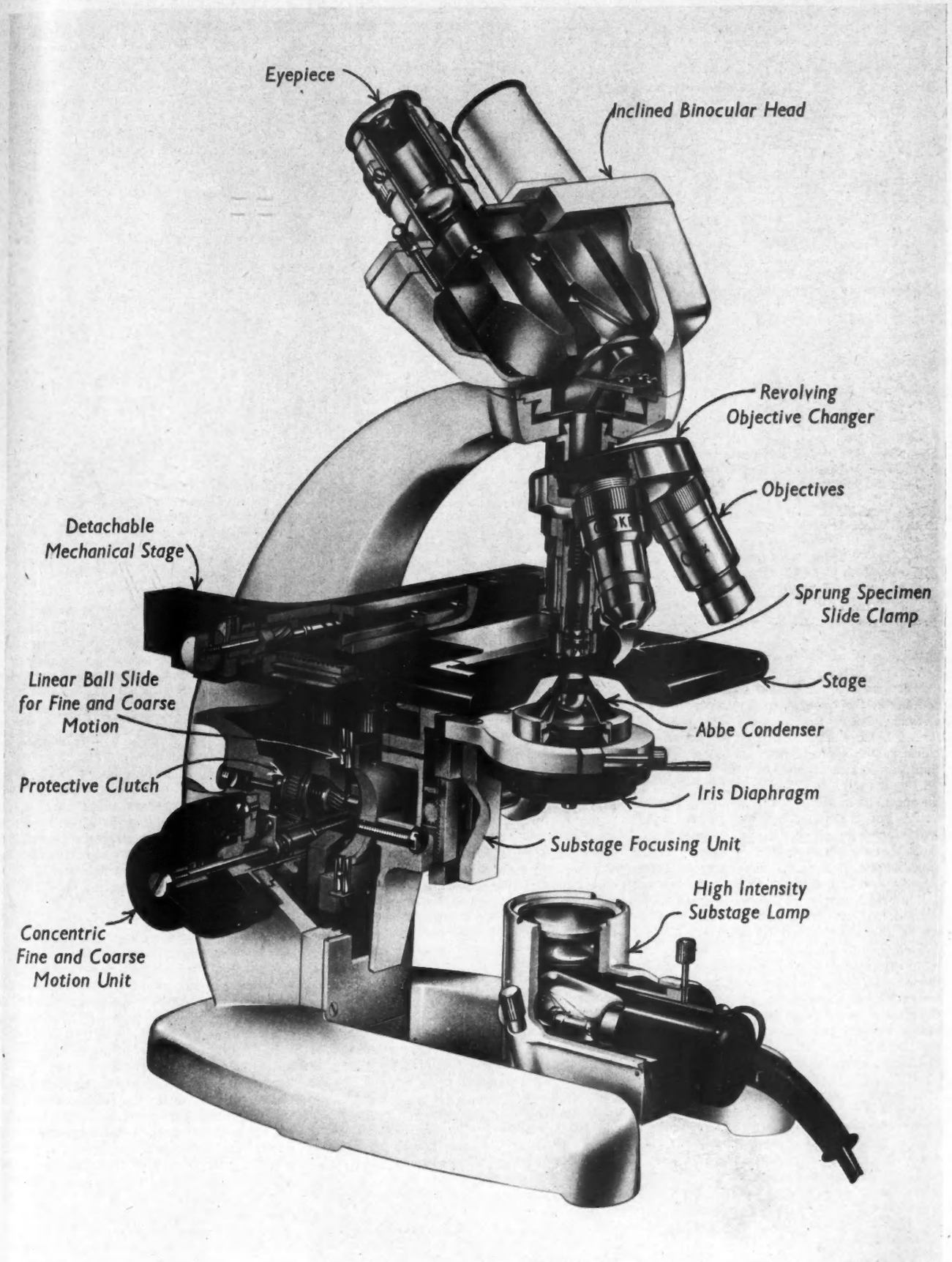


Fig. 3 Full mass production could not be adopted, but semi-mass production succeeded.

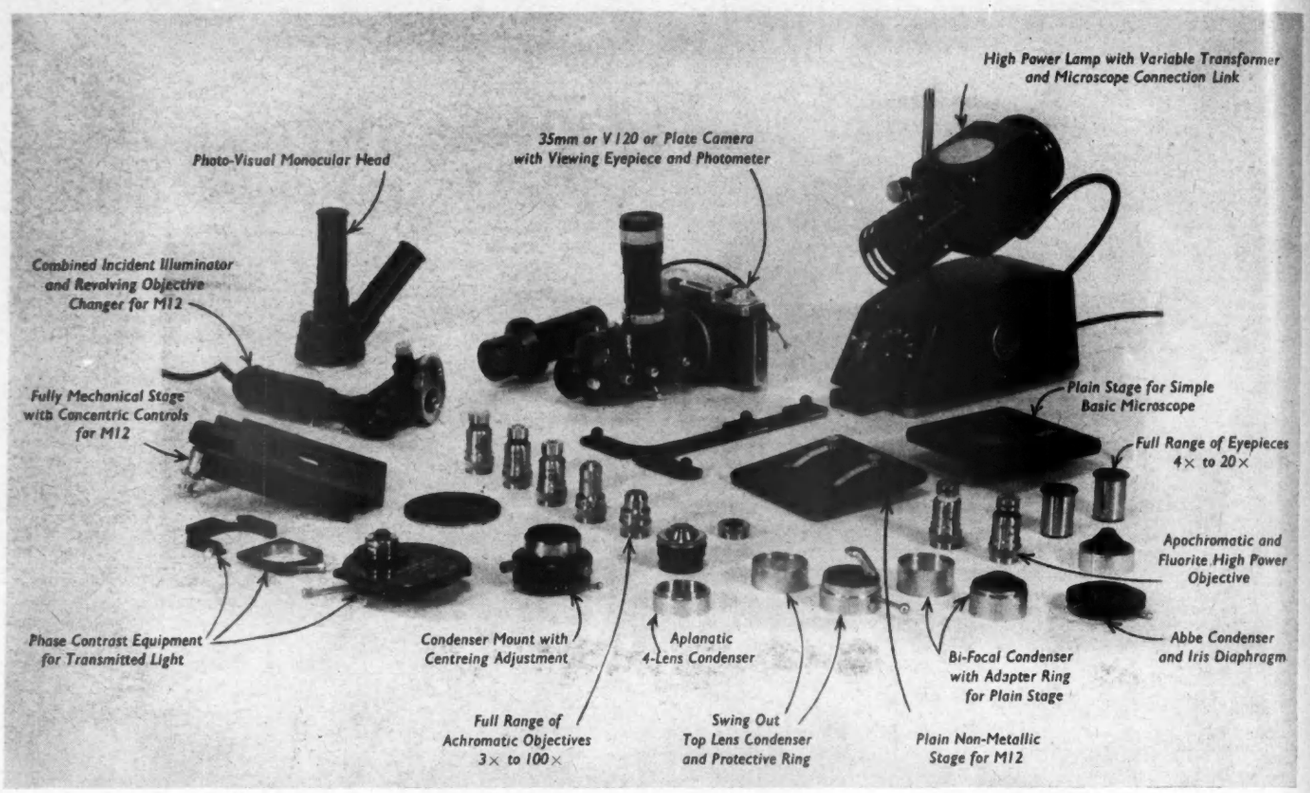

High Power Lamp with Variable Transformer and Microscope Connection Link
35mm or V120 or Plate Camera with Viewing Eyepiece and Photometer
Photo-Visual Monocular Head
Combined Incident Illuminator and Revolving Objective Changer for M12
Fully Mechanical Stage with Concentric Controls for M12
Plain Stage for Simple Basic Microscope
Full Range of Eyepieces 4× to 20×
Apochromatic and Fluorite High Power Objective
Abbe Condenser and Iris Diaphragm
Bi-Focal Condenser with Adapter Ring for Plain Stage
Plain Non-Metallic Stage for M12
Swing Out Top Lens Condenser and Protective Ring
Full Range of Achromatic Objectives 3× to 100×
Aplanatic 4-Lens Condenser
Condenser Mount with Centreing Adjustment
Phase Contrast Equipment for Transmitted Light

Fig. 4 Some of the accessories for the M12 metallurgical and M15 biological microscopes.

installation of a computer at Leeds University.

Another factor which influences the optical industry in this country is the intense competition in the overseas market, notably from Germany, but also increasingly from Asia. So far as home sales are concerned the optical industry, among others, has been protected from European competition since the First World War by the KID, or key industries duty. Other European countries have similar protective tariffs, but a gradual reduction of the tariff restrictions is proposed over the next ten years, probably culminating eventually in Free Trade with the rest of Europe. This prospect meant that the firm had to work fast in launching the M 15, which explains the tremendous concentration of effort in order to get production started after the go-ahead from the management.

Some idea of the threat of competition to the home market that removal of import restrictions implies may be gained from the fact that the German firm of Carl Zeiss, for example, turns out more apparatus than the whole of the British optical industry put together. Such a turnover puts Zeiss on a much stronger footing for paring production costs, all other factors being equal.

DESIGN DEVELOPMENT

Despite the fact that the various stages of development—namely designing the components, producing mock-ups and prototypes, and tooling-up—necessarily overlapped, hardly any part of the M 15 was scrapped during the critical twelve months of development.

In common with other modern products, new styling had been adopted in the M 25 which was repeated to some extent in the M 15. The styling in both series follows Continental practice, for example, in the grouping of the control knobs in a low-down position. An inclined viewing head was adopted (either monocular or binocular) to render the M 15 more convenient for the operator when seated. A vertical monocular head is also available as an alternative. A 35 mm roll film or plate camera can be fitted to the eyepiece tube. The camera attachment incorporates a watching eyepiece for observation up to the moment of exposure.

The stand consists of two separate pressure die-castings, the limb and the base, the rigid bolting together of which forms the first assembly line operation. To ensure stability, the base is of Mazac, a zinc-based alloy having a high density, while the stand is of aluminium.

Three mechanical features deserve special mention. As the clearance between the front objective lens component and the specimen may be as little as 0·007 in at high powers, the objective lens carrier is sprung to prevent damage should the stage be raised too high. Secondly, the fine and coarse motion knobs are concentric for convenience of operation, and operate on the same vertical slide. The fine motion is continuous throughout the range of the coarse motion. Thirdly, a protective slipping clutch is incorporated in the stage mechanism to prevent damage due to overtravel.

When ENGINEERING visited the assembly line, it was noticeable that the very high degree of manufacturing precision is treated so much as a normal everyday affair that it is almost taken for granted. No backlash can be tolerated in the fine or coarse motion assemblies; and locking pins and screws must not cause any part to "spring" or distort. Many lens glasses have to be contoured down to an accuracy of less than a wavelength of light. Also some of the lenses are very small, for example the front component of an objective can be a spheroid with a diameter of less than $\frac{1}{16}$ in.

Perhaps the most intriguing process to a visitor is that of setting the lens glasses in their metal rings or "cells." This is done by hand, the glass being cemented into the cell using Canada balsam. When the cell is warmed the balsam melts and the lens glass floats on a thin film. The lens is centred by a reflection method from a light filament some distance away, adjustment being made until the image remains stationary when the lens is rotated at high speed. The lens cells are made a sliding fit in the tubular lens mounts, and are located by a retaining ring.

FUTURE PROSPECTS

The M 15 is basically a simple biological microscope, but by judicious use of the accessories, some of which are shown in Fig. 4, it can be built up to full research standard. New accessories are constantly being added to the range, and it is clear that the M 15 has a long way to go yet before it reaches the end of its development. Accessories for metallurgical use were introduced a few months after the M 15, and in this form the microscope is called the M 12. To be introduced later this year is a third variant, the M 17, a polarising microscope for the petrologist, using another specially developed set of accessories.

Right from the start the new microscopes have sold well abroad. About 75 per cent of them have been exported since the introduction of the M 15. Very little customer criticism has been received up to the present time, though scientific users are by no means an uncritical section of the community. One problem is, however, ever present where delicate optical instruments are concerned, and that is damage during transit, particularly to distant parts of the world. The firm are about to introduce moulded expanded polystyrene packs that are inexpensive to produce and yet offer good protection against damage without putting the customer to the expense of a wooden container.

Incidentally, Cooke Troughton and Simms do not give a written guarantee with their microscopes, though there is a guarantee by implication. They rely on their good name to help the customer in trouble, and will do so free of charge if the trouble cannot be attributed to abuse. In their own words, "We sell the function of microscopy, rather than microscopes."

Panorama of Performance

The sports car driver and the racing motorist both seek high performance. Means of achieving it—from conversion kits to Grand Prix cars—were to be seen in quantity at the Racing Car Show.

By Brian Lister

FROM a technical point of view, the Racing Car Show, though comparatively small, was perhaps of greater interest than many of the larger international motor exhibitions. It was opened on New Year's Eve by the Earl Howe, and since the first show, a year ago, the organisers, the British Racing and Sports Car Club, have had to occupy the second Old Horticultural Hall, in addition to the first.

The supply of competition motor cars and parts in Great Britain has now become a minor independent industry. As evidence, there were over seventy commercial stands at the Horticultural Hall, and on these stands the various companies concerned presented for sale everything from books, gramophone records and films of motoring events to complete Formula 1 cars in ready-to-race condition. There were more than a dozen companies that offer tuning kits for various standard motor cars. Among these were Speedwell Limited, who were showing not only modifications for engines and suspension and exhaust systems for various standard cars, but also a complete modified or rebuilt car.

This model, based on the Austin Healey Sprite chassis, is shown in the illustrations, and will cost around £1,200 including purchase tax. It is a most attractive Grand Touring car, and is expected to have a top speed of about 110 mph. It is certainly good value for money, and I have a feeling that it will not be the only car that Speedwell will modify to this extent in the future. Neither are they likely to be the only firm carrying out such large-scale modifications to standard motor cars and chassis. This practice is, of course, already something of an industry in Italy.

One of the cars on the British Racing and Sports Car Club's own stand was the fabulous Austin A40 of Dr. Shepherd. This was the car that won the Club's National Championship for " Supatura " cars. The " Supatura " class allows for practically any change to be made to a touring car so long as the engine remains basically the same and the external appearance of the car is unaltered. It is therefore taking the art of modification and tuning to its logical, or if you prefer it illogical, conclusion.

Don Moore, who has his headquarters in Cambridge and is responsible for the engine tuning and overall preparation of the car, used to tune the engines of my own Lister-Jaguars. I was told by Mr. Moore that when the car was under test and at the peak of its development during the summer, it was capable of over 110 mph as against just over 70 mph for the standard version. It could accelerate from a standstill to 60 mph in 11 seconds, whereas the standard version could only reach this speed in 43 seconds. Bearing these figures in mind one can appreciate why the car has so often beaten relatively standard 3·4 and 3·8 Jaguars on the racing circuits of this country.

While I am sure that none of the exhibitors at the Racing Car Show would claim to sell conversion kits to give standard A40's this kind of performance, they can nevertheless considerably increase a car's performance for as little as £30 to £40.

Of course, one of the simplest ways of increasing motor car performance is by low-pressure supercharging. Shorrock Superchargers Limited offer a range of vane-type compressors for many cars, but one of the most interesting is yet to come on the open market. This is one they are preparing for the Austin 7 and the Mini-Minor. Figures quoted for acceleration are 60 mph from standstill in 16 seconds, as against 28·7 seconds for the standard version; Shorrock emphasise that these figures are provisional, being taken from the prototype and will almost certainly be improved.

In my own experience I have found that the new Austin 7 in perfectly standard condition is just as fast on a cross-country route in normal traffic as the large and ultra-fast touring cars. With acceleration of this kind at one's disposal there is no doubt that the small car in give and take conditions would be faster than any large touring car that is available.

Two new formula Junior cars were shown by manufacturers at the exhibition. One was the Lotus, exhibited publicly for the first time. The body section at the front is lower and rounder than the 1960 version, and the car also has a lower centre of gravity overall, which should give it even better road holding than the car had last year. The other was the new Cooper Formula Junior car, which has already won a race in America in the hands of Walter Hansgen, the American sports-car champion. The Cooper is also somewhat lower built than last year.

FORMULA JUNIOR

It is significant that both of these Formula Junior cars and the Emeryson, which has already been announced, a month or so back, now have 13 in wheels. This feature helps to reduce the all important unsprung weight of the Formula Junior cars, which of course have an overall weight limit. The next logical advance in cars of this class will be to bring the brakes inboard to cut unsprung weight even further.

Perhaps from the engineer's point of view the most interesting stands of all were those which were presented by the British Racing and Sports Car Club. There were four in all. The principal stand featured, as would be expected, the 1960 Formula 1 championship car, the Cooper.

On one side of the stand were the other 1960 championship cars, including the World Sports Car Championship vehicle, the 3 litre Testa Rossa Ferrari. This was the type of car (although not the actual one) that won the 24 Hour Race at Le Mans last year. The engine is of light alloy and is a V12 unit with cylinder blocks at 60°. Bore and stroke are 73 mm by 58·8 mm and the engine in its existing form is said to develop some 320 bhp as against a claimed 240 bhp when it was first introduced. The car weighs about 18 cwt as raced. Another Ferrari on the stand was the Berlinetta Grand Touring car, which was overall the most successful GT car of the year. It has basically the same engine as the Testa Rossa, but develops some 40 bhp less and weighs approximately 2 cwt more. The car still has a performance well in excess of 150 m.p.h. and what is more it may be purchased as a road car in this country if you have £6,326 to spare.

Another car in the GT class on the stand of the champions was the Lotus Elite which, as most readers will know, is of fibre-glass construction as far as the chassis and body unit are concerned.

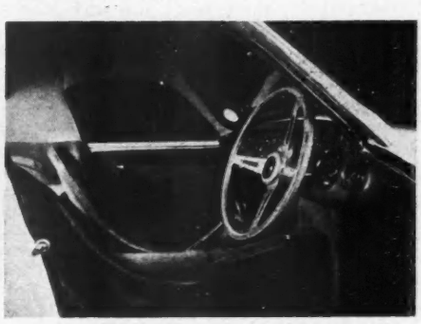
The honours in Formula 2 racing this year were shared equally by Cooper and Porsche, but as the Formula 1 and Formula 2 Cooper are the same, other than the power unit, the British Racing and Sports Car Club showed a Formula 2 Porsche with the familiar trailing arm Volkswagen-based front suspension, but less familiar rear suspension by double wishbones. There is no doubt that the Porsche is the best made and has the finest finish of the present range of international racing cars. Among other cars on the stand was a Formula Junior Lotus.

On the other side of the centre dias there was the stand for cars of technical interest. Vehicles shown here included the rear-engined BRM with a 255 bhp 4 cylinder engine of 103 mm bore by 75 mm stroke. This is the car with the single transmission disc brake at the rear. The dry weight of the car is quoted as 10 cwt. It was interesting to compare the size of the Vanwall on this stand with the Formula 1 1960 Cooper. The Vanwall exhibited was the 1959 version that was not raced because of Mr. G. A. Vandervell's retirement from racing at the beginning of 1959.

There was also one of the new Lotus 19 cars, the first rear engined Lotus sports car to be produced. It is basically similar in chassis design to the Lotus GP and FJ cars: the body is partly glass fibre and has a cut-off tail, which is reminiscent of the Cooper Monaco rear-engined sports car.

It is unfortunate that the " bird-cage " chassis Maserati did not appear for the exhibition as promised. This would have been a most interesting car to examine, with its complicated chassis design and unusual body. It is almost certainly the last of the front-engined Appendix C cars to be designed. And in fact this car has brought yet another change in the Le Mans regulations: this time for the 1961 race (certainly the last year for Appendix C cars). The Maserati last year had the bonnet and windscreen made from one piece of moulded Perspex with a consequent low angle from the horizontal, forming a rather impractical, but nevertheless highly efficient windscreen. The Le Mans regulations for 1961 call for a minimum windscreen angle.

Another car of immense technical interest which, however, was not on this stand was a 1955 Mercedes GP car. It was displayed on the " Webbair " Charter Flight Company stand, and was lent by Lord Montagu. The fourth official stand, which was in the other hall, showed some historical racing cars including a 1924 GP Sunbeam; a Type 35B 1924 Bugatti (one of the most successful racing cars ever); a P3 Alfa Romeo GP car of *circa* 1931, the type which was so successful until the advent of the pre-war Mercedes and Auto Union teams in 1934. We were brought up to date as far as racing history is concerned with a 4½ litre V12 Ferrari GP car, which was raced under the name " Thinwall Special " in this country and was one of the first cars entered from the Vandervell stable; a 1958 Vanwall, the first car to bring the GP constructors championship to Great Britain, and a D Type Jaguar sports car.



The Speedwell Grand Touring car is based on the Austin-Healey Sprite chassis. (Right) Interior.

On the Shelf

By Frank H. Smith

I HAD a request from a man the other day for information on a subject about which there is almost no book material but which is covered by periodicals. So far so good. But there he is stuck in some technical college in some God-forsaken hole up north (no names, no daggers-in-the-back), so periodical references such as I would supply would be useless. How then, do these poor devils get on? In fact, how *do* technical colleges outside the biggest cities get on? I know that even here in London, students at some of the top-rank colleges get most of their stuff from my library. When these Colleges of Advanced Technology were mooted, Aslib had a whacking great conference on the subject of their libraries. I wonder if anything ever came of it? I wonder if anybody took any notice of it?

Back in 1955 (I don't think we'd met then?) the British Gear Manufacturers' Association (301 Glossop Road, Sheffield 10) issued the first edition of their buyers' guide. This has now been revised and reprinted and is available from the secretaries, Messrs. Peat Marwick, Mitchell and Company, at the address given. I think the association's title is sufficient explanation of the sort of thing the guide contains, but if you take the trouble to get a copy you may get more information than you bargained for.

Most of the stuff I write about is quite beyond me and outside my sphere (which is slightly smaller than the ball-point of a ball-point pen) so for what it's worth I offer *Alphabetical Index to Tables of Chemical Kinetics, Homogeneous Reactions*, National Bureau of Standards Circular 510, Supplement 2; 37 pages and 35 cents. The Stationery Office will get it (and I hope HMSO does not mind all the extra work my thousands of readers thrust on them).

Edward (the map people) Stanford Limited, of 12-14 Long Acre, London, WC2, announce a " Catalogue of Maps published by the Directorate of Overseas (Geodetic and Topographical) Surveys," at 10*s*, plus 2*s* 6*d* postage for home and 5*s* for overseas. All purchasers will automatically get monthly map additions which can be fed into the loose leaf binder.

Crassly ignorant as I am, I am not well acquainted with the work of Arthur D. Little, Inc., but their *Industrial Bulletin*, number 379, has some strong things to say about the charging system obtaining in libraries, with particular reference to America, of course, since the address of the Little Inc. is Cambridge, Mass.

Six useful pamphlets have come from Cement and Concrete Association (52 Grosvenor Gardens, London, SW1). Under the general heading " Digital Computers: Specifications for the Use of Programmes " they are each devoted to a different programme with, of course, concrete application.

The Philips Electrical organisation (in England, at Century House, Shaftesbury Avenue, London, WC2) is a fine example of far-sightedness in its industrial outlook. They now announce that an issue of service manuals covering the company's current radio and television range is to be made to all the main technical colleges throughout Britain. This replaces the former system whereby technical colleges received the books on request.

The Special Libraries Association, 31 East Tenth Street, New York 3, thank the Deputy Editor for his request but regret that the review list of a " Checklist for the Organisation, Operation and Evaluation of a Company Library " is closed and hope that the enclosed brochure will be helpful. Which means that the Deputy Editor will have to shell out $2 if he wants a copy—which I doubt. How the devil any librarian can specify what books (apart from the lot one learns in library exams) any particular company can require, beats me. But then, I'm learning all the time.

Casting Metallurgy

Chemical Analysis of Cast Iron and Foundry Materials. By W. WESTWOOD and A. MAYER. 2nd Edition. *Allen and Unwin.* (63*s*)

On the laboratory shelves of most iron-foundry metallurgical chemists are to be found well-thumbed copies of the original edition of " Westwood and Mayer." For nine years, this book has been looked upon by the experienced chemist as a standard work of reference and by the laboratory apprentice as a methods textbook from which he could derive good instruction. The new edition is similarly strongly bound and contains 20 more pages of text, printed on stouter paper, and should remain even less mutilated than its predecessor in its hazardous life in a routine chemical laboratory.

The original authors having undertaken new responsibilities, the revision was entrusted to Mr. W. E. Clarke, F.R.I.C., and Mr. H. Green, who have followed them into similar posts in the laboratories of the British Cast Iron Research Association. This research association is staffed by investigators of international reputation on matters pertaining to cast iron. The very high standard of its workers is reflected in publications such as this.

The book opens with a general account of chemical laboratory practice and then deals in turn with sampling and analysis of cast iron, ferro-alloys, iron ore, slags, refractories, coke, foundry requisites, and so on. Readers not familiar with the iron-foundry industry may be surprised to find in this book so many methods of analysis, each carefully tried and tested, for the 25 elements commonly found in modern engineering cast iron. Chemical analysis is the basis of metallurgical control and there are few foundries which do not have the services of a laboratory. To avoid argument, every laboratory must adopt standard methods of analysis and their chemists have come to regard " Westwood and Mayer " as the arbiter.

The form of the original edition is retained but the analytical methods have been extended modified or replaced in the light of experience gained not only at the British Cast Iron Research Association but by dozens of analysts engaged in work in the same or similar fields. In the foundry industry there is no lack of cooperation between its chemists, and the efforts of the BCIRA Methods of Analysis Sub-Committee has helped materially in giving the selected procedures the stamp of authority.

The authors' style is straightforward. While the " recipe form " is adopted to describe the analytical procedure, the chemical principles involved are always discussed and theoretical explanations are given. As a work of reference, this book is likely to be consulted via the index which is perhaps the weakest part of the book. Cross references such as " blast furnace slag: see slags " are frequent. To the chemist in a hurry, this is irritating.

Finally, the appendix in 12 parts contains, among other items, useful tables, works of reference, notes on standard samples, laboratory equipment, temperature measurement. The new edition costs 63*s* and is not merely desirable but is essential to all practising metallurgical chemists and foundry laboratory workers.

R. V. RILEY

Studying Hot Liquid Systems

Physicochemical Measurements at High Temperatures. Edited by J. O'M. BOCKRIS, J. L. WHITE and J. D. MACKENZIE. *Butterworths Scientific Publications.* (75*s*)

It is probably not far from the truth to say that engineers have contributed more, directly, to the fundamentals of the science of heat and the concept of temperature than to any other branch of pure science. Watt, Carnot, Rumford and others not only developed practical devices of immense value, but also had the time, foresight, and ability to lay the foundations of thermodynamics, one of the pillars on which modern science has built extensively.

The stimulus given by the rapid developments of the last two decades in power production and propulsion systems, which are in turn affecting, metal and chemical production technologies, has centred more and more on research for materials able to withstand a variety of severe conditions, one of which is almost invariably high temperature. In the present age of blurred distinctions between science and engineering it has been inevitable that a large number of engineers working in these or allied fields have become increasingly interested in the fundamental physics and chemistry of systems at elevated temperatures. A book on the practical aspects of scientific methods in a specialised field is always welcome to those becoming familiar with the subject, especially in a field such as high temperatures where present development is rapid, and when the universal shortage of time is coupled with a shortage of comprehensive and up to date handbooks. The latter derives partly from the fact that owing to the military importance of much of the work, information has been held back for security reasons. More recently this information has become less restricted and several excellent handbooks on high-temperature technology have appeared.

The book under review, however, is more restricted than its general title implies. It contains information obtained mostly by one group of workers (originally at Imperial College in London) and primarily on liquids at high temperatures. For this reason it may be disappointing to those interested in materials research, and one feels that the book could better have been entitled " Physico-Chemical Measurements in High Temperature Liquid Systems," as both solids and gases are given only the most cursory of treatments. Even in the chapter dealing specifically with solids (which in other ways is admirably written) little emphasis is placed on physical and chemical measurements at elevated temperatures, and the prime consideration is their stability as refractory containing materials at high temperatures.

Each chapter is written by a different contributor, and both the standard and the style of writing vary considerably. Editing books of this sort (and in these days of increased specialisation, when it is unfortunately becoming more and more unusual for one or two authors to write a book that can be considered in any sense to be both specialised and comprehensive, they are becoming increasingly common) is difficult under the most favourable conditions, but when the contributors are in different continents it must be formidable. As a result, some of the chapters in this book are too brief and too limited in scope in comparison with the high standard of the others. While one can appreciate their editorial difficulties one can recommend that editors should be more ruthless in excluding chapters the contents of which, possibly through no fault of the contributor, prove more limited than anticipated, and contrast with the majority. A book, as distinct from a symposium, should preserve balance and as uniform a standard throughout as possible.

The book can be divided into two main parts. The first and more general part comprises a thorough, well written, and comprehensive description of the theory of measuring high temperatures and the practical aspects of furnace design, control and operation. Combined with

the practical appendices on such topics as the preparation of molybdenum and tungsten apparatus, thermodynamic tables, and the thermal expansion of materials (but why as an appendix?) this section of the book has been found by the present writer to be very useful in high temperature research on solid materials.

The remainder of the book, apart from the chapter on refractories, consists of essays by specialists on various techniques for studying the nature of liquids at high temperature, and in most cases they are excellent treatments not conveniently obtainable elsewhere. The methods dealt with include phase equilibrium in silicate systems; chemical equilibria between gases and condensed systems and between liquid systems; calorimetry of metals; liquid densitometry surface tensions; vapour pressures; a variety of electrochemical measurements; optical scattering and absorption in fused salts; ultrasonic velocities in melts; diffusion in liquids; and viscometry.

If one accepts the restriction of the subject matter to liquids there is one gap in this list. Fusion receives only incidental mention throughout the book, and considering the value of, say, entropies of fusion, it is a relatively serious omission. Less serious, but annoying, is the fact that the reviewer has found several of the references do not refer to what is ascribed to them.

The practical applications of the information gleaned by the methods in this book lie mostly in those metal refining industries concerned with slag and metal melts, particularly the steel industry. Engineers in this field should certainly acquaint themselves with these techniques, especially as what was the laboratory experiment of yesterday can frequently be scaled up to be the engineering experiment of today. (Not surprisingly, the results frequently disagree, as the conditions may differ widely, suggesting that the main application of a scientific investigation is more often than not the extension of the technique to a full-scale experiment rather than the laboratory results as such. This comment may sound like heresy from a scientist, but it is a fact that is sometimes inescapable.) Many of the techniques described here could probably be readily adapted to pilot-plant experiments in the metallurgical industries, and if so would adequately repay study.

It is an understandable difficulty to know how much theory should be included in a practical book, and it is probably not a bad thing that discussion of the theory of liquids as such is almost entirely absent from these specialist chapters except where applicable to the method under consideration; otherwise the treatment would become unweildy. The unity of the book could, however, probably be strengthened by a quantitative extension of the opening chapter on the relevance of the data from the various methods to the theory of liquids at high temperatures, and their relation to the general theory of the liquid state.

The above may sound unduly critical in the adverse sense but this is not intended as the book contains a great deal of very useful material and has stimulated not a few ideas in at least one research laboratory working on high-temperature chemistry, and as a practical manual the book has much to commend it. To bring it up to the standard of usefulness and completeness that it almost reaches, however, it is believed that if the editors modify the title, the balance and the theoretical content in the second edition (the book is certainly good enough to warrant a second edition) it will then become an invaluable addition to the few good handbooks on the science of high temperatures. If at the same time it can be enlarged to cover gas and solid state methods, without making it cumbersome, the book will be correspondingly still more valuable for both scientists and engineers with a scientific bias.

The production and layout of the book is excellent with well spaced print, clear illustrations, a bold type for references and a good index.

R. F. DEACON

Cylindrical Shaft Structure

Reinforced Concrete Chimneys. By C. PERCY TAYLOR and LESLIE TURNER. 2nd edition. *Concrete Publications Limited, 14 Dartmouth Street, London, SW1.* (12*s*)

Practising civil and structural engineers who are faced with the design and construction of reinforced concrete shafts of any description will recognise the value of *Reinforced Concrete Chimneys*, by Taylor and Turner. Mr. Leslie Turner, who must be rated as one of the foremost authorities on this subject in the United Kingdom, has now revised this remarkable little book, which has been in a class of its own for twenty years. He has done so by improving its presentation, by simplifying it where possible, by the discrete use of headings, and by bringing it bang up to date with modern thought and practice, but without in any way changing its character. Aimed at both engineer and student, the new edition eliminates some of the tedium of mathematical analysis from the text, but includes it in an appendix for the benefit of those who have the urge.

On the broad development of concrete chimneys, he discusses some of the earliest, and some of the latest and tallest constructions, with ample coverage of details and photographs. The section dealing with wind pressure has been extended by introducing the latest information arising from recent research, and includes a graph providing an envelope of wind pressures for flat and round surfaces covering recommendations by the American Code, by British Standard C.P.3, and by the author himself. He gives some personal guidance on designing for wind forces abroad, and also describes how earthquake conditions can be catered for.

Calculations for weight and wind have now been given a separate chapter, and the author has simplified the task of the designer in determining combined vertical stresses due to weight and wind, by the introduction of a range of graphs (using $m = 15$) based on a new method of analysing annular sections devised by the author himself.

Stresses arising from temperature gradients are examined more extensively by introducing recent test data on the subject, and the author offers his solution to this problem for use in designing biological shields. The section dealing with combined temperature and other stresses is basically unchanged, but new ground is broken by the introduction of a chapter on deflection and sway, in which steady pressures, dynamic effects, and the problems of instability are discussed. He sets down in relatively simple terms the means for determining the natural frequency, and damping effect of the structure, and provides a "plain man's guide" to preventing the development of dangerous oscillation.

As before, the author presents a complete example of the design of a chimney using the devices set down in his text. Flue openings, capping details, lightning conductors, linings (supported and unsupported), foundations, and other features are handled in a practical manner, but in detail appropriate to their relative importance. He has now introduced a generous bibliography and a simple index.

The reader should guard against confusion due to the dual notational use of "e." In the third chapter "e" denotes the eccentricity, namely $\frac{M}{W}$, but in chapter five "e" is the net strain on the neutral axis due to temperature.

Into this improved version is compressed a wealth of up to date design data and practical knowledge. It is presented in a clear and concise manner, and while it is written primarily for the practising engineer, the student will find it an invaluable aid for specialised studies on this subject, and for his future engineering needs.

T. C. WATERS

Tasks in the Cosmic Laboratory

Science in Space: Chapter 2: The Nature of Gravitation. Chapter 3: The Earth. Chapter 4: The Moon. Chapter 5: The Planets. Chapter 7: Physics of Fields and Energetic Particles in Space. *National Academy of Sciences, 2101 Constitution Avenue, Washington 25, DC.* ($1 each)

Knowledge of the microscopic structure of the universe has increased very rapidly over the last few decades, thanks primarily to the existence of the twin goals of cheap abundant nuclear power and (less happily) cheap annihilation of rival cultures. On the cosmic scale the motives have been entirely peaceful and the effort smaller, but sweeping revision of the old theories of the universe has had to be made as a result of the work with the big new optical and radio telescopes.

Now spaceflight is with us, although the motivation is again primarily military rather than scientific, the opportunity to make a completely fresh study, with new tools, of the space around us has arrived. Already the masses of data which are being returned to the earth from satellites and space-probes are throwing light on the nature of the solar system—in fact the threat of too much information to process is already being realised. However, as payloads increase, the flexibility of the experimental equipment should also increase and the number of scientists who can find valuable work in space (by remote control at first presumably) should rise as well. The report under review is aimed primarily at these scientists and those in authority over them.

The authors were set an almost impossible task—a detailed review of every aspect of space science within about 150,000 words. They have accepted the challenge and produced a valuable and comprehensive report. It is published in nine separate "chapters," available separately as they are completed. At the time of writing only five were available, namely, chapters: (2) The Nature of Gravitation (R. H. Dicke); (3) The Earth (Harrison Brown, G. P. Woolard, Harry Wexler, Alan Shapley and O. G. Villard, Jr.); (4) The Moon and (5) The Planets (H. C. Urey); and (7) Physics of Fields and Energetic Particles in Space (J. A. Simpson, E. N. Parker, J. A. Van Allen, and J. W. Chamberlain). Chapters on the sun, galactic astronomy and the biological sciences, and a general review are to follow.

Each chapter is built around a somewhat similar framework and the editing has achieved a very good balance between the authors, although emphasis is, perhaps naturally, more

on physics than astronomy. Each section starts with a clear concise review of the present state of knowledge of the subject, followed by a discussion of an exhaustive list of subjects for study and of possible experimental techniques. The references and supplementary reading lists in particular are excellent, except perhaps that those in Professor Urey's chapters, The Planets in particular, are rather too brief.

The reviewer, working as he is on projects involving hardware which many of us hope will be used for such experiments, found all five chapters thoroughly absorbing. As a piece of technical writing it is difficult to classify, but this uncertainty is only because its three objectives demand rather different types of treatment. It is aimed partly at specialist scientists looking for information about the "state of the art" in allied fields, possibly with a view to planning future work, partly at men with the task of administering the now very expensive field of scientific exploration, and partly as a general review of the subject for the interested scientist, amateur or professional. All three need a different standard of writing but all will be able to enjoy and profit from a reading of any, or all, of the chapters. Graphical rather than mathematical treatment has been used wherever possible.

At $1 each all the chapters so far issued are well worth having. The chapters on the moon and planets fall short of the others in detail (and are therefore even easier to read, if not quite as valuable), but this limitation is only because comparatively little is known yet about the rest of the solar system so that the detailed planning of experiments is much more difficult. Nevertheless, Professor Urey's discussion wastes none of its more than 12,000 words.

If the chapters come up to the high standard set so far the whole report will be an extremely valuable contribution to the planning of our space-borne experiments. The text deserves a place on the library shelf—it is to be hoped that it will soon appear as a single volume.

S. R. DAUNCEY

Scaffolding

Civil Engineering Handbook. Edited by LEONARD CHURCH URQUHART. 4th Edition. *McGraw-Hill, New York and London.* (135*s* 6*d*)

A comprehensive reference book, this fourth edition of the *Civil Engineering Handbook* divides its subject matter into ten sections. To give an idea of the scope of engineering subjects covered, these sections include: surveying; railway, highway and airport engineering; mechanics of materials; hydraulics; stresses in framed structures; steel design; cement and concrete; reinforced concrete; soil mechanics and foundations; sewage disposal; water supply and treatment.

The sections have been brought up to date, several have been entirely rewritten, and generally the handbook will be of great use both to graduates and to practising engineers.

The various subjects are contributed by engineers well known in their own special spheres and are comprehensive and practical, with excellent diagrams and modern data.

The references and general bibliography are extensive and cover extremely wide fields of civil engineering practice and design. The handbook contains a wealth of information, both theoretical and practical, and there is new and developed material in this revised edition.

W. P. SHEPHERD-BARRON

New Books

Engineering Management. By STRUAN A. ROBERTSON. 2nd edition. *Blackie.* (30*s*)

The author divides his subject into three parts: the art of management, which he defines as "the art of creating industrial relations, in order to secure cooperation"; the science of management, in which he considers the scientific method of ascertaining and handling the innumerable facts and observations on which industrial agreements and relationships are based; and the practice of management, the major part of his book, which he considers from initial market research, through production, to sales.

Semiconductor Technology: A Series of Papers Revised and Reprinted from "Research," 1958 and 1959. Edited by G. K. T. CONN. *Butterworths Scientific Publications.* (10*s* 6*d*)

These 12 articles do not pretend to comprehend the whole field, but rather to present a simple survey of typical topics. They include information on silicon and germanium transistors and the preparation of ultra-pure silicon and germanium, alloy junctions, infra-red photocells, bismuth telluride and related compounds, and solid state devices.

Principles of Machine Woodworking: Sawing and Planing. By A. H. HAYCOCK. 2nd edition. *Technical Press.* (15*s*)

Primarily intended for apprentices and newcomers to the industry, this is one of a series of five volumes. The new edition takes in such technical developments as improved devices for the spring setting of circular saws, the band re-saw which is gradually ousting the roller-feed circular saw, and, probably the most important, the increasing use of tungsten carbide tools.

The Proceedings of the Diamond Jubilee International Clean Air Conference, London, October 1959. *National Society for Clean Air, Bream's Buildings, London, EC4.* (30*s*)

Seventeen countries were represented in the 78 papers presented at the conference, and the subjects covered included education and legislation aspects, dust removal, diesel fumes, local investigation results, and the possibilities for international cooperative research.

CABMA Register of British Industrial Products for Canada, 1960-61. 8th edition. *Published for the Canadian Association of British Manufacturers and Agencies by Kelly's Directories, and Iliffe.* (15*s*)

Over 3,000 British products available to the Canadian market are listed, with their suppliers given under each heading. A directory of some 4,000 British firms gives details of their distribution arrangements in Canada.

Determination of the Mechanical and Technological Properties of Metals. By B. M. GLINER. 2nd edition. *Pergamon Press.* (50*s*)

Translated from the Russian, this book covers all the types of test likely to be encountered in the Soviet literature, defining the principal terms and the testing variables, and including brief descriptions of the major types of testing equipment.

The Machining of Steel. By F. C. LEA and ERIC N. SIMONS. 2nd edition. *Odhams Press.* (21*s*)

This book was originally written to help the large numbers of untrained men and women who found themselves thrust into the machine shops of engineering factories during the war. It presents the fundamental principles of the processes, together with practical details of the machines and methods used.

Theory of Thermal Stresses. By A. BRUNO BOLEY and JEROME H. WEINER. *Wiley, New York and London.* (124*s*)

The subject of thermal stresses ranges from classical topics to material which is still in a tentative form—the present book presents a broad account of all current theoretical techniques for the determination of stresses produced in a solid object when subjected to specified heating conditions.

Sell's British Aviation, 1960. 13th edition. *Business Dictionaries Limited, St. Dunstans House, 133-137 Fetter Lane, London, EC4.* (20*s*)

An alphabetical section of companies engaged in aeronautical engineering and related fields is followed by a classified guide to aircraft, engines, parts, accessories, and materials; airlines, charter companies, and other services. A directory of interested societies and associations is also included.

The Fifteen Wonders of the World. By RENE POIRIER. *Gollancz.* (25*s*)

The author's selection of engineering wonders in this very readable account includes the Pyramids, the Great Wall of China, Roman roads, the Underground, the Forth Bridge, the Eiffel Tower, the Panama Canal, the Simplon Tunnel, and the Oak Ridge atomic power project (somewhat incomprehensively illustrated with photographs of ZETA and Dounreay).

Mechanics for Textile Students. By W. A. HANTON. *The Textile Institute, Manchester; Butterworths, London.* (30*s*)

A reprint of the 1954 edition, this introduction to mechanics draws on textile machines and processes for its examples, and stresses those aspects of the subject which mainly concern the user rather than the maker of machines.

The Reviewers

Dr. R. V. Riley is research manager of the Stavely Iron and Chemical Company Limited, and senior vice-president of the Sheffield Branch of the Institute of British Foundrymen. He is a fellow of the Institution of Metallurgists, and a member of the Iron and Steel Institute, the Institute of Metals and the Society of Chemical Industry.

Dr. R. F. Deacon is engaged in work on high-temperature chemistry in the research laboratory of the Morgan Crucible Company Limited.

Mr. T. C. Waters is chief structural engineer in the Development and Engineering Group of the United Kingdom Atomic Energy Authority, and a member of the Institution of Structural Engineers.

Mr. S. R. Dauncey, B.A., A.F.B.I.S., is a technical officer working on satellite launch vehicles and orbits with the Astronautics Division in the Advanced Projects Group of Hawker Siddeley Aviation Limited.

Mr. W. P. Shepherd-Barron, M.C., T.D., LL.D., M.I.C.E., M.I.Mech.E., was until 1953 chief engineer of the Port of London Authority. He is also a Past-President of the Institution of Civil Engineers.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Machine Tools

Stock List. F. J. EDWARDS LTD., 359-361 Euston Road, London, NW1. Stock list of used and new machine tools including lathes, saws, borers, and grinders. Catalogue MT 1260, 32 pp. illus.

Tool Grinder. DOWDING AND DOLL LTD., 346 Kensington High Street, London, W14. Scherrer HSM 20-80 tool grinder for carbide tools; high production rate. Illustrated brochure.

Bandsaw. VERROLEC LTD., 721 North Circular Road, London, NW2. Barson-Rollox horizontal band saw with seesaw action for lower cutting pressures and higher speeds. Leaflet illustrated.

Honer. A. A. JONES AND SHIPMAN LTD., Narborough Road South, Leicester. Hydrohoner model 715 has rotary power feed and automatic sizing. Maximum bore diameter 6 in and spindle stroke 15 in. Brochure 8pp. illus.

Croppers and Presses. PILOT WORKS LTD., Manchester Road, Bolton, Lancs. Hydraulic presses with capacities up to 15 tons and croppers to take ½ in flat steel. Illustrated folder.

Abrasive Cutter. B. O. MORRIS LTD., Morrisflex Works, Coventry. Wallace abrasive cutting machine, 16 and 20 in models taking tubes up to 4 in and 6 in dia. respectively. Also accessories. 8 pp., illus.

Automatic. DOWDING AND DOLL LTD., 346 Kensington High Street, London, W14. Accuratool single spindle automatic with plug-in programming. Folder 4 pp., illus.

Bandsaw. L. S. STARRETT CO. LTD., Jedburgh, Roxburghshire. Bandsaw blades in coil or cut to length. Tables of sizes and recommendations for materials. 8 pp., illus.

Magnetic Chucks. DARWINS LTD., Tinsley, Sheffield 9. Fimax permanent magnet chucks from 6 to 24 in diameter with removable centre plug for through drilling. Folder, 4 pp., illus.

Machine Tool Drives. ASSOCIATED ELECTRICAL INDUSTRIES RUGBY LTD., Rugby. *Machine Tool Drives* is a comprehensive publication covering a.c. and d.c. motors, built-in stator-rotor units, thrustors and selsyns, as well as static switching and servo controls. 80 pp. ill.

Marketing

Three New Frigates for the Royal Navy

SUPPORT for the shipyards of the Clyde and the Tyne is indicated by the announcement of the three new frigates —all of the Leander class—to be built for the Royal Navy. Two will be built on the Clyde and one on the Tyne.

On Clydeside one of the frigates will be built by SCOTTS, of Greenock, and the other by JOHN BROWN'S, of Clydebank. The third, already made known, will be by SWAN, HUNTER AND WIGHAM RICHARDSON, on the Tyne.

The ships, costing about £7,500,000, are expected to take about two years to complete. Warship constructors had been invited to enter tenders for the three new ships.

Quick Look Round Leyland's 1960

Looking over their shoulder at 1960, LEYLAND MOTORS report that their overall export of vehicles rose by about 30 per cent. Truck shipments were up by 16 per cent and buses by almost 60 per cent.

African and Australian markets were well ahead of the field in truck orders during the year. Asian and European customers ordered the greatest number of passenger vehicles.

Jamaica, Pakistan, Greece, Finland and Bolivia all ordered valuable numbers of trucks. South Africa, Israel, Jamaica, Uruguay and Argentina increased the length of the bus order book.

Leyland vehicle production rose in response to the demand by more than 20 per cent and engine production went up by 40 per cent. In all, buses and trucks were exported to more than 50 countries.

Smaller USA Car Imports and South African Quotas

Two items of news at the close of the year brought no consolation to the motor industry. The first, a report from the United States Department of Commerce, said that car imports to America in the first nine months of 1960 fell by 23 per cent. A further decline is expected by the department.

It puts the cause of the switch in the market as the popularity of the compacts. More specifically, the compacts are said to have appealed to the new car buyer because of their advances in engineering, their quality and their fresh styling.

Though the introduction of the compacts has put American car makers in a better position to compete in the mass export markets of the world, the Department of Commerce points out that tariffs, quotas and internal taxes still constitute barriers to the increased export of assembled cars.

The second piece of unwelcome news came from South Africa where the Government, hoping to reduce its car import bill in 1961 by around £30 million, is to cut down the quotas for imported cars by about 15 per cent. The quota reduction will also affect firms assembling imports.

An attempt to hold the crumbling South African balance of trade, this move will affect the British motor firms who have found rising sales in South Africa some help in the present difficulties.

Expanding Industry in Malta

Eight new factories for which approval has been given on the Marsa Industrial Estate, Malta, are expected to be completed by July of this year.

One, of 18,000 sq. ft, will be used for glove making by DENT, ALLCROFT (OVERSEAS). Three of the new works will be of 25,000 and four of 12,500 sq. ft.

The market research survey being carried out for the Government of Malta is to appear soon. This report will also cover tariffs, quotas, import regulations and other physical and financial barriers affecting exports of Maltese manufactured goods to the countries around the island.

A significant piece of Lancashire-Malta cooperation is the sheet and towel producing cotton factory of RIGG WELTS, whose second factory has recently gone into production. The Lancashire element in this enterprise is the old-established company RIGG BROTHERS.

They have found at least one common difficulty shared by Lancashire and Malta. This is over labour for a night shift. Neither in the British industrial north-west nor on the sunny Mediterranean island are the mothers favourably disposed to the idea of their daughters being away from home at night.

Cars and Textiles

But Mr. Roger Rigg, the chairman of Rigg Welts, now expects that two day-shifts will be in operation some time next month. A third Rigg Welts factory, covering 150,000 sq. ft is now being built. It will employ an estimated 550 people.

The factory to be used by RAMBLER AUTOMOBILE ASSEMBLY for car assembly is almost completed and 1961 Rambler saloons and station wagons will be leaving the works very soon. The car assembly factory, of 110,000 sq. ft, will have been finished within six months of starting work. The advanced equipment to be used by Rambler includes an electronically-controlled welding plant and a paint section some 400 ft long.

For DOWTY SEALS'S Maltese subsidiary, MALTA RUBBER, work has begun on a 12,500 sq. ft factory which should be ready in April. First employment will be of about 120 people and all the output is to be exported.

Of their island development, the DOWTY GROUP chairman, Sir George Dowty, has said: "This move has been brought about largely because of rapid business expansion and acute labour shortages in our present Seals factory. Malta offers the ideal solution to our problems because it has plenty of the right sort of labour, and has many other advantages."

Among three important applications received by the MALTA AIDS TO INDUSTRIES BOARD is one from a company proposing to manufacture gold-bonded diodes and transistors. Initial employment would be for 50 people, with an eventual increase to 1,500.

PHOENIX TEXTILES have applied to set up a factory for spinning cotton and man-made fibres, developing later to weaving and making up dresses. A first requirement of 200 employees is expected to rise to 700. The third application is for the manufacture of bulked nylon and Terylene and the knitting up of the yarn into hosiery.

MAIB has recommended an application from MEDITERRANEAN WIRE ROPES for the production of wire rope on the island.

Maybach Diesels for Six New Trawlers

Twelve MD 225 BRISTOL SIDDELEY Maybach diesels, of 394 bhp each, have been ordered for six new trawlers—the first orders of these high-speed diesels for British marine application.

The engines will power trawlers to be built for T. MITCHISON Limited of Gateshead, to the design of BURNESS CORLETT AND PARTNERS. Single screw vessels of hydroconic form, the trawlers are for middle water operation. They will have a loaded speed of about 11 knots. Operation will be by the PELAGIC TRAWLING Company, of North Shields.

Bristol Siddeley explain that the two engines in each trawler will be coupled to a single Hindmarsh/Berg controllable pitch propeller through an MWD twin input, single output reduction gearbox, from which a drive will also be taken to the winch generator.

Selection of high-speed diesels for this application was for reasons of service requirements of long life and reliability and a high power output for low weight and bulk.

Bristol Siddeley's MD range of engines is manufactured under licence from MAYBACH MOTORENBAU GmbH, of Freidrichshafen.

There have already been numerous German marine applications of the Maybach diesels, and a greater number in railway traction. There are about 100 Maybach-powered vessels in service around the world.

Machine Tool Orders Rising

The latest Machine Tool Trades Association figures show that machine tool orders at the end of October last year were 83 per cent higher than twelve months earlier. For the month of October alone the flow of new orders was 45 per cent greater than in October, 1959.

October's total deliveries were worth 13 per cent more than a year earlier but export deliveries, which had been going up at a more rapid rate than to the home market, were 5 per cent down.

Some of the strength in home orders is due to orders being placed by the motor manufacturing firms. In the export markets the traditional areas continue to do well and the most important of the newer customers are the United States and Japan.

MTTA Machine Tool Figures (£'000)

	Home		Export	
	October 1960	October 1959	October 1960	October 1959
Deliveries during month ..	6,073	5,035	1,996	2,108
Order book at month end ..	79,245	38,827	23,097	15,311
Net new orders	9,352	5,912	2,382	2,167

Australian £3 Million Contract for AEI

ASSOCIATED ELECTRICAL INDUSTRIES are to supply the largest thermal generating unit yet ordered for the Southern Hemisphere and transformers to operate on the highest voltage system in Australia.

This equipment, worth £3 million, has been ordered by the ELECTRICITY COMMISSION OF NEW SOUTH WALES. The generating unit, to be commissioned in 1965, is for a power station north of Sydney, at Vales Point. Its output will be 275 MW. The generator's stator windings will be water cooled, a technique which was first pioneered by AEI and put into service in 1956.

The second part of the contract is for 13 transformers, worth altogether £1 million. Seven of these will have a rating of 133 MVA and will operate at 330 kV. The remaining six will have a rating of 60 MVA and will operate at 132 kV. All 13 transformers are due delivery in 1962.

The generating unit is to be made in Manchester and the transformers at Rugby. In the circumstances of excess capacity in the heavy electrical industry, with rising costs and intense international competition, the order puts a rather brighter face on the start of the year.

Ferranti Transformers

For their Vales Point power station the ELECTRICITY COMMISSION OF NEW SOUTH WALES, Australia, has ordered three 3-phase generator transformers from FERRANTI Limited, placing a contract worth more than £400,000.

Ferranti were in fierce competition with Asian and European firms.

The three 240 MVA, 16·5/348 kV transformers, will be the largest ever to be built with aluminium tanks in the United Kingdom. The use of aluminium tanks will keep the weight of each unit down to 147 tons, a material advantage in easing the considerable transport problems.

Contract negotiations were through WILSON ELECTRIC TRANSFORMER Company Pty., of Melbourne, who will install the transformers, the first of which is due to be delivered at about the end of 1961.

Special transport arrangements in Australia will include a specially built road-rail wagon. It will make part of the journey, over New South Wales Railways tracks which will have the return track closed and operate for the occasion on single-line working.

For the last part of the trip the 75 ft long road-rail wagon will have its rail bogies replaced with pneumatic tyred road wheels and be towed to the site by large diesel engined tractors.

Materials Processing

Minerals, fuels, chemicals, plastics, elastomers, coatings, refractories, metals and alloys. Bearings, nuts and bolts, chemical plant.

THERE was a time when all new materials appeared, in the written word, to have a use in missiles. Certainly credit must be given to the aircraft industry for posing some very troublesome materials selection and evaluation problems, but there is now an appreciation of the fact that real money is obtained by the *commercial* acceptance of a material—which means production in thousands of tons instead of the publication of pretty pictures of development items.

Design and Development

The only broad comment that can be made about materials in 1961 is that no new family is likely to emerge to upset established contacts between materials users and materials makers, in the way in which plastics have done just this in the last decade. What is needed, and what is already being provided by most suppliers of raw or semi-finished materials, is technical service, and this means having men who are so clear regarding what material should be used for any given application that they know when to say "no." Materials are so basic to engineering design that it does not help anybody's reputation to obtain a supply contract for a new, but unsatisfactory, material. The past year has been one of consolidation in material evaluation, and if only this tendency continues, and designers can be helped to exploit what is already in existence, it would not matter greatly if no further basic new material were to be introduced in the next hundred years.

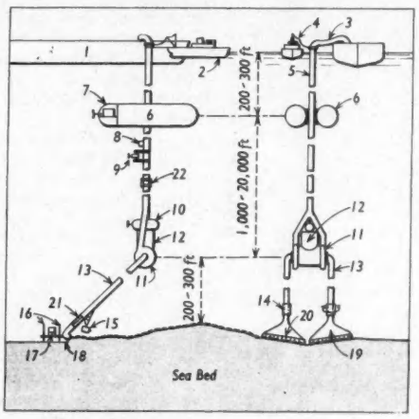
To turn to the consideration of details. During 1960, several new sources of raw materials were proved and opened up for commercial exploitation. The Sahara, for instance, is proving a large source of mineral wealth.

Petroleum products from most wells which have yielded anything substantial have been uncomfortably high in natural gas and "petrol" fractions. This position has attracted the attention of the Gas Council, who are in consultation with Conch International Methane on the plans for construction of a liquefaction plant on the shores of Algeria. Mr. G. le B. Diamond, chairman of the West Midlands Gas Board, reported last October that such a plant would take about two years to build. His principal interest in the project is because methane, with its high calorific value, would be useful for enriching the gas made in the new Lurgi gasification plant at Coleshill.

Much discussion is still going on respecting the exploitation of minerals obtained from the sea. Magnesia is now produced by precipitation by Steetley Magnesite Company Limited, and one of the first commercial plants has been opened this year for extracting potable water from seawater on the island of Guernsey.

Other people have been examining the seabed in their searches for mineral deposits, as an alternative to seeking those in solution in the water itself. In this connection, nodules have been discovered, principally in the Pacific Ocean between South America and Tahiti. Estimates now place the total content of these substances present in the oceans at 198,000 million tons, but no commercial scheme has been proposed.

In the field of abrasives and precious stones, the big announcement of 1960 was that the de Beers group would be undertaking the production of synthetic diamonds. There has been a temporary closing of the Congo mines producing natural boart (the diamond dust used in abrasive wheels) but this situation is expected to be no more than a temporary problem. Just twelve months ago, it was announced that the Diamond Corporation had concluded an agreement, under the terms of which all diamonds of Russian



1. Nodule collecting and storage barge.
2. Hydraulic dredge service ship.
3. Nodule transfer line of flexible rubber hose.
4. Electric marine cable.
5. Delivery pipeline.
6. Submerged hydraulic-dredge floats.
7. Propulsion motors to move the dredge in the direction of dredging.
8. Gyroscope control.
9. Propulsion motor for propelling dredge pipeline in direction of dredging and keeping the pipeline in vertical alignment.
10. Main propulsion motor.
11. Main hydraulic pump.
12. Main pump motor.
13. Suction arm pipeline.
14. Swivel arrangement that would allow the suction head to rotate around axis of suction arm.
15. Rotational TV camera.
16. Hydraulic rams.
17. Motor and pump to provide water flow for lifting nodules into the suction arm pipeline.
18. Skids to prevent suction head from sinking too far into bottom sediments.
19. The suction heads.
20. Screen to prevent oversized material from entering the pumping system.
21. Barred opening to vent water and fine sediment.
22. Back-flow valve to vent the nodules from the pipeline in case of a pump or motor failure.

Two views of a proposed hydraulic mining dredge which could extract about 4,000 tons of manganese nodules a day from the sea bed. Reprinted from Mobil Industrial Review.

production which are exported to the West will be purchased by the Corporation and sold through the central selling organisation of the de Beers group. Thus, the Russian threat of deluging the world market (they have proved the existence of large deposits in north-east Siberia and the northern Urals) has been removed, although most of their output would, in any case, be absorbed domestically. De Beers have insisted that natural industrial stones are superior to synthetic ones, but they can, apparently, see vast improvements coming in the synthetic product, and appear loathe to let the General Electric Company in the United States dominate the synthetic field.

This end of 1960 saw advertising prominence being given to the advantages of liquefied petroleum gases (LPG) as a fuel which could be used for almost the entire needs of factories. Henry Wiggin, in Hereford, faced with the difficulty of obtaining a gas supply for their factory extension, are one company to have taken up this development. Internal-combustion engines used for materials-handling equipment benefit especially from clean running and the reduction of the carbon-monoxide content of the exhaust gases by about 60 per cent, which result from the use of LPG. Conversion kits are now available for several BSA, Villiers, Petter, Lister, Wolseley, Jap and Scammell engines. Since there is every indication that LPG prices, for supplies delivered to consumers in bulk, will drop, these fuels deserve careful consideration.

British Petroleum announced two months ago that they intended building an oil refinery at Belfast which would cost about £8 million, initially. It should be completed in two years.

In the field of lubricants, molybdenum disulphide had another successful year, and no research work was done which threw any serious doubt on the empirically-derived fact that the substance is a useful lubricant in its own right, and equally useful when combined with greases. Rolls-Royce have recommended spring lubricants containing the additive for use on Silver Cloud II and Bentley S2 cars. Use was extended to steering linkage, track rod joints, front drag links and the intermediate lever system with a maintenance life of 10,000 road miles, on these models.

The United Kingdom benefitted in the way of sulphur from the French exploitation of the Lacq oil and gas fields. In 1959, the United Kingdom was the chief foreign purchaser when France exported 200,000 tons compared with a domestic consumption of only 180,000 tons. Natural gas is now used in a plant completed only weeks ago at Beck D'Ambes in Western France to make carbon black.

Next year, Hawker Siddeley Nuclear Power Company should really get into their stride in finding people who can benefit from use of impermeable graphite. They have spare capacity in their plant and are seeking outside orders. This product is an expensive but attractive one. More down to earth, however, the know-how for producing large crack-free blocks of normal graphite is being collected. Thus, in October last, the National Carbon Company in the United States made a 30 ft column of graphite with a section of 12 in by 14 in.

Not much has happened in the thermoplastic field so far as technical advances are concerned. British Geon have come up with a high-strength pvc suitable for piping, which has medium impact strength and good ageing properties, and several firms now offer the substance in semi-finished forms, such as pipes and fittings. British Nylon Spinners are going to make nylon 6 in this country—it has been imported till now in small quantities—but the material will probably make most impact on the fabric market, because it can take dyes and pigments better than nylon 66.

Hercules Powder Company have introduced a chlorinated polyether known as Penton into the United Kingdom, but its cost is on a par with ptfe, at about 10 times the present cost of polyethylene per lb. Du Pont, also, have brought a plastic in from the United States, although it is unlikely that the demand for it will be large enough to justify a polymer-production plant other than the one at Wilmington, at least for several years; the material, of course, is Delrin.

In thermosetting plastics, the up-and-coming materials (though still low in tonnage) are fibre-filled doughs; these benefit from being thoroughly mixed at the factory, but still need heat-curing cycles measured in tens of seconds.

The past year has seen British Railways experimenting with reinforced plastics. Noteworthy among their efforts were rail-road containers made by the North Eastern Region. Their Pl container is only half the weight of a conventional A type and allows an extra ton—from four tons to five tons—on the tare weight. Southern Region have also put a lot of thought into the design of doors for electric trains.

Glass-reinforced polyester has been popular for boat building. Thus, the P. and O. liner Canberra has been fitted with reinforced-plastic lifeboats made by the Viking Marine Company. The Oriana also has boats made in this material.

One of the difficulties which must be overcome is fire resistance. Grades of glass-reinforced polyester are available at extra cost which will resist fire, but they are not popular for marine use because they do not weather very well.

Improvements in the characteristics of plastic foams are continually being made. Research has been directed towards preventing the almost sudden collapse of the polyurethane foams used in upholstery and in getting a more gradual build-up in load as the material is compressed. The polyether type has been becoming prominent and Aeropreen introduced one in 1960 which is fire resistant.

A very simple material which should not go unnoticed is uncured ptfe tape. When wound around pipe threads, the joints can be tightened up easily, while yet giving a perfect seal with high chemical resistance. William Rose and Crane Packing both supply these materials.

Two of ICI's products based on polyesters are meeting with a good response. Terylene fibre is now a domestic byword and the company have had to expand rapidly. Extensions to the Wilton plant, now under construction, are due to come into full operation in 1962. When the same resin is made into film, the result is a very tough, brilliant and chemically resistant film which ICI call Melinex. The company are constructing plant which will have a capacity of 2,000 tons a year when it is complete later in 1961.

Although not strictly a reinforced plastic, the term is really quite apt for pitch fibre. For the first time since 1957, when it was formed, the Pitch Fibre Pipe Association has made an annual report. In looking forward to the future, the chairman emphasises the low cost of sewage and drainage-pipe installations made in this material.

In spite of the large number of coatings now being made and well-tried for preventing abrasion, most chutes for coal and ores are still being made of unprotected plate steel riveted up on site. But there are movements afoot to evaluate and install protective coatings in this connection. Two linings have great futures. The first is a glass-reinforced plastic one, and the second is the glass lining in tile form. As an example of the first, the National Coal Board, faced with drilling out rivets from a chute and resetting them, decided to try instead a coating nearly ½ in thick applied by Extrudex.

Semtex have accumulated experience in lining hoppers with glass tiles set in resilient mortar, and there are several hoppers for such materials as iron ore now lined in fused cast basalt, which is another glassy material imported into the United Kingdom by two companies, R. B. Hilton and Cast Basalt Products. The use of basalt is interesting, owing to the fact that dams on the mountainous rivers Naryn and Vakhsh, in Russia, have been faced within the last year with volcanic basalt. About 1,700 tons were remelted and poured into position at parts of the dams subject to water erosion.

Coatings of plastic, whether applied as paste or powder, are increasingly seen, and those based on pvc can now be applied with adhesion which is as great as the strength of the coating itself. When a higher temperature coating (130° C for example) is required with good chemical resistance, it appears that the new plastic Penton will be useful, especially since it can be fused to give an impermeable layer. Ptfe, although inert to most chemicals, is virtually impossible to obtain in an impermeable coating. However, for anti-stick applications it is attractive, and a code of practice has been published by the British Plastics Federation.

Mr. R. Spencer Copeland, retiring president of the British Ceramic Society, attacked the industry in September last; stating that "the ceramic industry, employing 150,000 people and turning over £200 million a year is not devoting enough money and effort to securing the future." He deplored the lack of graduate scientists employed on ceramic research, the secretiveness of individual firms, their parochial outlook, and the absence of cooperation between various sections of the industry.

Nevertheless, Mr. Copeland represented an industry which is kept going at full pressure and, in seeking new refractories, it is easy to lose sight of the extreme cheapness of many established refractory bricks.

The use of castable refractories is on the increase, and this reflects two things. First of all, after prolonged evaluation, such as in marine boilers, it has been shown that a castable refractory can perform as well as many prefired bricks. Second, it reflects the needs of furnace builders to have new shapes made cheaply and quickly. By using a castable, the cost of preparing moulding dies is obviated.

Future Events

Oil and chemicals will feature prominently in the early months of this year. Sometime in 1961, underwater drilling in the North Sea for oil by platform Triton is to be put in hand by the Shell International Petroleum Company.

Among metals, the largest aluminium rolling mill of its kind in western Europe begins operations for James Booth Aluminium of Birmingham during the year.

In plastics, there will be a conference on rubber and plastics in cables in March, and three important dates in June for plastics as such. These are, a conference on education and training in plastics, the international exhibition at Olympia, and another such exhibition at Ghent. There will be the biennial surface coatings conference at Torquay on the turn of May and June.

External Factors

The Foundry Trades Exhibition at Birmingham in 1959 set the trend of development in the foundry industry in perspective for the next few years with its theme of automation. Mechanised casting has indeed spread from iron and steel to glass. But, perhaps, the breakdown of conservatism in this industry is nowhere better illustrated than in the widespread adoption of blowing carbon dioxide into mould boxes using silicate binders. Today, over 80 per cent of foundries in this country use the process.

Increased automation and the improvement of casting techniques to reduce fettling may be the forseeable line of advance but the resulting increased productivity must mean either fewer concerns or a much bigger output.

Greater automation in foundries brings scope for larger shot-blasting units. Wider use of mechanical shotblasting is one of the current trends in industrial processing. It was only as recently as 1956 when the first, and only, British steel-shot plant was erected. The development of the chromium-molybdenum steels has greatly extended the life of steel shot. Mechanical-blast units are spreading throughout the industry, but more slowly in shipbuilding and structural engineering. The possibilities of extending the life of paintwork by using a thorough descaling process is, however, gradually gaining wider acceptance.

Shotblasting is also being found to extend the life of tools. A recent investigation showed that, in structural engineering, the cost of descaling by hand cost 25*s* a ton, while shotblasting could do the job for 8*s* a ton. The big advance, however, may be in plastics, where output continues to expand, if at a slower rate; for shotblasting has proved more economical than the old expensive hand methods of removing flash.

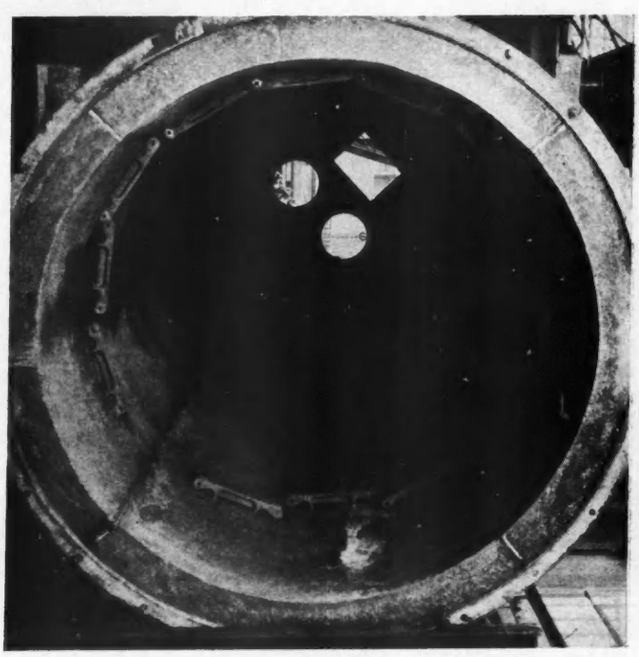
Market Trends

An industry which has been experiencing competition in export markets recently has been that of mining machinery. Deliveries were £53 million in 1958, £46·5 million in 1959 and are likely to have been about £44 million in 1960. Exports in the first half of 1959 were valued at 4·7 million, but were down to £3·9 million in the corresponding period of last year. The big drop in exports was in well-drilling machinery, a not unexpected consequence of the recession in the world oil industry and its curtailed investment programme. The recession is likely to recover, however, and exports of mining machinery may rise with it. Meanwhile, competition has been keen, especially from the United States and Germany. Last year, 33 companies came together to form the British Mining Equipment Export Association, the aim of which is to foster exports.

To judge from the turnover figures of the big chemical companies the chemical industry continues to be exceedingly prosperous. ICI raised its turnover in the first six months of 1960 to £288 million, compared with £250 million in the first half of 1959. Capital expenditure, however, has eased off slightly. That of ICI, for instance, was scheduled to be slightly lower in 1960 than in 1959, although the chairman did not say at the time by how much the figure would decline.

Management and Labour

Reference has already been made to the conference on education and training in the plastics industry during the coming summer. The conference is symptomatic of the efforts which all industries are having to make to attract some of the limited supply of promising technical and managerial manpower, and train it from their



Castable and mouldable refractories are increasingly used. This shows a vermiculite/Ciment Fondu lining cast into a Born direct fired process heater made in the UK by H. and E. Lintott.

own facilities. Most materials-processing industries are capital intensive. That is to say, they have a high output per worker and a large amount of plant and equipment per operative. Some of them, the chemical industry in particular, have a tradition of training their more able operatives and staff up to supervisory level, and of recruiting senior staff from university graduates or their equivalent.

Employment in this group of industries pursues an uneventful course. It has been steadily going upward for some time and is likely to continue so. But the issue of promotion from junior to senior management, and its relation to technical qualifications is going to be a source of rethinking and possibly of tension. More men trained entirely within their respective companies are going to compete for the top jobs. Will they get them without lowering technical standards in the process? How will automation and the trend towards mass production affect the issue?

A pause, while the chemical industry works its recently installed capacity up to the peak output, is at present reflected in the deliveries of new chemical plant. In 1958, deliveries of chemical plant were £50·3 million. They fell to £37·3 million in 1959 and, to judge by the trend in the first half of 1960, they are likely to have been about £35 to £40 million last year.

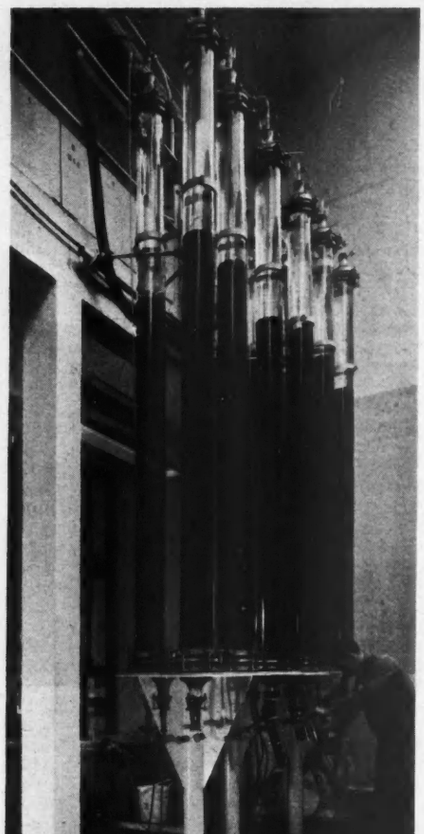
Exports of gas and chemical machinery have also faltered, while imports have increased. In the first half of 1959, as shown in the accompanying table, imports were approximately £2·9 million, compared with £1·8 million in the first half of 1960.

Imports and Exports of Selected Processing Machinery
(Six months to 30 June, 1959, and 1960, £000)

	Imports		Exports	
	1959	1960	1959	1960
Gas and chemical machinery	2,862	1,791	321	507
Glass making and glass working machinery	113	265	438	831
Grain milling machinery	855	1,085	—	—
Mineral oil refinery machinery	455	825	—	—
Packing, packeting, bottling (including bottlewashing), canning and labelling machinery	2,733	2,997	1,314	2,053
Plastics and rubber working machinery, not elsewhere specified	4,434	6,017	1,819	2,068
Presses, plastics, moulding, other than tableting and palleting	569	603	—	—
Bearings, ball and roller ball bearings including parts	1,302	1,494	544	953
Cocks and valves (other than for motor vehicles) of brass and other alloys of copper (excluding nickel alloys)	806	935	—	—
Industrial valves, wholly or mainly of iron or steel, other than for motor vehicles	5,348	6,062	—	—

Exports went up from £321,000 to £507,000. The point about these statistics which gives cause for concern is that they may be casting a shadow. The annual report of the British Chemical Plant Manufacturers' Association for 1959, published in July, 1960, drew attention to this trend in their external trade. The Association pointed out that even the good performance by plastics and rubber working machinery owed a great deal to the erection of a tyre plant by a British consortium in Russia. The Association were very much of the opinion that the worsening was due to the exclusion of this country from the European Common Market. Opportunities for expanding sales in the countries of the European Free Trade Association are much less, in the Association's view, than those which would exist in the Common Market countries, if the United Kingdom were on the right side of the Common Market tariff barrier. The chemical plant industry seems to be set for a period of struggle in its export markets.

One way round the problem would be for companies established in the United Kingdom to set up subsidiaries, enter into partnerships, or make licencing arrangements with countries in the Common Market. There has already been some activity on these lines and there is likely to be more in the near future. An example of what might increasingly happen was the creation of Leybold-Elliott last summer by a subsidiary of Elliott-Automation on this side and by Leybold's, of Cologne, on the other. This new concern is British and Elliott-Automation have the controlling interest. The new company will export the high-vacuum equipment of both parent groups to Commonwealth markets (excluding Canada) while Elliott's products will be marketed in certain European countries by the German group.



Development of ion exchange techniques has made it possible to produce rare earths in quantity and in a state of high purity. These are some of the ion exchange resin columns in the Johnson Matthey plant.

Stirrings as a result of the establishment of the European Common Market and the European Free Trade Association are occurring elsewhere in materials processing. In the bearings industry, for example, the Swiss SRO Ball Bearing Work Schmid-Roost, Limited, one of the largest bearing manufacturers in Switzerland, have opened a sales office in London, and the Skefko Ball Bearing Company Limited (long established here as a Swedish subsidiary) are extending the larger of their two factories at Luton and putting up a new factory at Irvine in South West Scotland. On the other hand, an effort to extend the organisation of enamel-ware manufacturers in the Common Market to cover European Free Trade Association countries has failed.

Production

Last year was a record one for the steel industry, whether measured by production, exports, capacity available, or capital investment. At just over 24 million tons, crude steel production was some 93 per cent of effective capacity, which had risen by the end of the year to 26 million tons. The record annual expenditure of £130 million also increased finishing capacity, but, as much of this came in late in the year, the full effects will not be apparent until the plants are completely run in.

Among the outstanding developments which came into operation during the year were the new 4-high plate mills at Consett and South Durham, the plan of the latter including a completely new integrated works; in Scotland, the reconstruction of the Hallside Works at Colvilles, including a new billet mill, to produce special and alloy steels; and, at John Lysaght's Scunthorpe Works, the expansion of the coke, sinter, pig-iron and rolling capacity.

The planned developments of the industry will, of course, continue in 1961, when it is expected that at least £150 million will be spent on modernisation and expansion. A significant proportion of this sum will be absorbed by the two new strip-mill projects now under way at Richard Thomas and Baldwins and Colvilles. The other two sheet producers, the Steel Company of Wales and John Summers, are also proceeding with their plans. By the end of 1961, it is estimated that crude-steel capacity will have risen to 27 million tons and major strides have been made towards increasing sheet capacity and obtaining further capacity for producing the new Universal beams. During 1961, two new mills producing these improved and more efficient sections will be installed at Colvilles' Lanarkshire Works and at the United Steel Companies' Appleby-Frodingham Works, and this progress will be followed by a similar development in 1962 at South Durham's Cargo Fleet Works.

The ease with which consumers will be able to obtain their supplies of steel will depend, to a large extent, on the state of the national economy and the level of activity in the various consuming industries. Sheet capacity is continuously rising and, with the lowering of demand in the car industry and the consumer durable industries, imports of sheets (most of which went into stock in 1960) will probably no longer be required, although some imports are inevitable as a result of commitments entered into some months ago. Should there be any further reduction in these industries' demands for cold reduced sheet, it is likely that manufacturers will be able to increase their output of other types of sheet if these are required. These types would include galvanised and plastic-coated sheet. This latter material is now being produced by eight companies in the United Kingdom, and some serious promotion work is beginning to bear fruit.

It was the increase in activity in the engineering and constructional industries which brought about the rise in demand for steel in 1960. Here, the new 4-high plate mills will obviously increase the availability of plate, where there should be few problems of supply, and an increased production of the new Universal beams to meet the growing demand will come from the two new mills when commissioned later this year.

Nuts and bolts rarely stir the imagination of the engineer, except on questions of standardisation. This industry, however, had the distinction in 1960 of having its price-fixing agreement held valid by the Restrictive Practices Court. Members of the Black Bolt and Nut Association were told that only the quantity discount allowed under the agreement was against the public interest. The Court considered that prices had been reasonably based on costs, allowing a profit level which, whether related to turnover or capital employed, could not be considered excessive. A feature of the judgment, which may well be very relevant for some sections of the engineering industry in the future, was the benefit which the Association gained in the eyes of the Court for a genuine attempt to charge reasonable prices. This fact outweighed the Court's view that the basis of estimating costs could have been rather

less rudimentary. The warning was added to the judgment that, if the Association were to change the basis of their computation of prices on to some basis which could be shown to be unreasonable, the Registrar could again take action. The effect of the abandonment of the discount system would, of course, increase the profits of the manufacturers.

Less encouraging than the processes of law has been the trend of imports and exports in nuts, bolts and screws. Imports of nails, bolts, nuts, washers, rivets and screws in the year 1959 amounted to £864,000. In the first half of 1960, they were already up to £785,000. In exports, the whole year 1959 recorded £8·7 million, and, for the first half of 1960, £3·7 million. There will have had to be a big recovery in the second half of 1960 to make up the ground lost in the first half. Figures such as these mean growing competition from the highly-mechanised plants on the Continent, once the European Common Market and the European Free Trade Association become thoroughly established.

Expansion and Investment

On the lighter side, the completion towards the end of 1961 of the Lancashire Steel Manufacturing Company's continuous bar-and-rod mill at their Irlam Works and of developments to the wire-rod mill at the Tremorfa Works of Guest Keen and Nettlefolds will increase capacity by about a quarter of a million tons.

Capacity for producing alloy and special steels has recently been increased by the completion of the Hallside Works in Scotland. Among the projects to be completed in 1961 are the 75 ton electric-arc furnace and vacuum-casting plant at the English Steel Corporation's River Don Works; the Sendzimir mill for rolling 48 in stainless-steel strip at Richard Thomas and Baldwins' Panteg Works; and the installation of further plant and equipment for processing hot and cold-rolled alloy and stainless-steel sheet, following the modernisation and improvements already completed this year by Samuel Fox and Company. As new uses are continually being found for stainless steel, demand is rising, but the output of stainless steel is also increasing at a fairly rapid rate.

It is expected that, in general, the home consumption of steel in 1961 will rise little above the 1960 level and, taking into consideration a possible rise in exports, steel production this year is likely to increase to some 24½ million ingot tons. Such a level of production will represent about 90 per cent of the higher capacity of 27 million tons, so that were demand to rise more rapidly, a higher steel production could be achieved.

The way in which technical change interacts on turnover in the home and export market can be seen in the history of galvanised sheet production. In the first half of 1960, imports of uncoated plate and sheet came to nearly £26 million compared with just over £6 million in the first half of 1959. So great has been the pressure of recent years on domestic supplies of cold reduced sheets and tinplate that the production of galvanised sheets has been given a very low priority in the United Kingdom. Available wide strip-mill capacity has been fully utilised in catering for the motor-car and canning industries. Time was when this country was the world's largest producer and exporter of galvanised sheets, a position now lost to Japan. It has been estimated that by the late 1960's only four sheet-galvanising units, out of a world total of 80, will be located in this country. The recession in the car industry may now provide the occasion for second thoughts. There is a case to be examined for producing more galvanised sheet, or, if the car industry quickly recovers, for installing increased capacity.

Over the last year, plastics output increased by 16 per cent. The official index of the output of manufacturing industry over the same period increased at about half that rate. In the first half of 1960, the total output was 290,000 tons. Stocks, however, were rising throughout 1960. Signs during the twelve months were that the phenomenal expansion of recent years was beginning to lose its impetus. From the users' point of view, the outlook is still good. For instance, there are now five makers of polyethylene—Bakelite, British Hydrocarbon Chemicals, Imperial Chemical Industries, Monsanto, and Shell—and their combined capacity should be about 170,000 tons a year by the end of 1961, which is far greater than the possible demand. The ICI plant for polypropylene is now on stream and Shell's plant will be completed in 1961. Pvc remains in great demand and is the one material which has had to be imported in recent years. These imports will partly be avoided when the two extensions to pvc plants, as announced by ICI and British Geon, are in production.

In a recent article in *Rubber and Plastics Age*, the director of commercial planning for the Texas-US Chemical Company analyses very completely the plans for the world production of synthetic rubber during the next five years. At one point, he states: "It would appear that in addition to 46 existing plants, about 24 new plants will be built to total approximately 70 synthetic rubber facilities operating in 16 different Free World countries by 1965."

In the United States, it is estimated that 20·6 lb of rubber will have been consumed *per capita* in 1960, including 69 per cent of the synthetic product. In terms of *per capita* consumption, Great Britain lies fourth, with a figure of 11·7 lb; of which an estimated 37 per cent will have been synthetic rubber. When compared with the percentage of 24 of synthetic rubber in 1957, there is seen to have been a large increase, but it reflects the speed with which synthetic rubber facilities are being built throughout the whole of Europe and brought into operation.

In the United Kingdom, the International Synthetic Rubber Company have been working to a capacity of around 90,000 tons a year of the lowest-priced SBR rubbers, including several thousand tons a year of latex.

Shell announced that they will build a plant to make what is known as "synthetic natural" rubbers with a capacity of 20,000 tons a year. This plant should go into operation in 1962. These rubbers are closer to the molecular structure of natural rubber than previous ones, and have resulted from new catalyst systems. One type of the two most commonly known, polybutadiene, is what Dunlop have incorporated in their Elite tyres.

A further major extension to the United Kingdom's synthetic rubber facilities will come about when Esso Petroleum Company's plant for butyl rubber comes into production in two to three years' time. Polymer Corporation, in Canada, who supply most of this type of rubber at present, are also known to be considering production in Europe and probably in the United Kingdom. This rubber is best known for its low permeability to gases, so that its main use is for inner tubes and liners for tyres.

Long Term Research

The amount of theorising and fundamental research continues but except in fields such as missiles and electronics, more time could be spent in evaluating existing materials than fanciful thinking. There is still far too much research work on material behaviour, which is performed on samples obtained commercially, with no attempt being made to find out how variations in production techniques can modify these properties.

But with this tendency in mind, here are a few topics which will be food for many people's thoughts in the coming year. Surface condition is the first. What effect has this condition on fatigue and crack propagation? Research into the problem can be expected to produce metal, ceramic and glass fibres with great strengths, and this is talking in terms of production quantities.

Even once these fibres have been produced, however, there are great difficulties attached to bonding them together into a structural mass. With glass, the medium can conveniently be resins, such as epoxies and polyesters; but, even here, some large increase in strength and resistance to fatigue and creep might come from a real understanding of surface condition and bonding processes.

The need for cheaper communications over long distances will probably justify the vast expense of research and development needed in putting satellites into orbit. And the heart of this project is in the radio transmitters and receivers—lightweight in the air, and with high sensitivity on the ground. From the mumbo-jumbo of metal physics has emerged the semiconductor and the maser, and these will be responsible for the success of such ventures. But while firms, such as ICI and Monsanto, grapple with the task of making germanium and silicon for these devices with impurity levels around the 1 in 10^9 level, it is interesting to explain away why similar semiconducting behaviour is shown in commercial purity metals. Commercially-made silicon carbide, such as is used for flame tubes in furnaces, can be doped with trace elements and made to produce thermoelectric emfs.

In the field of high temperature alloys, the concept of vacuum melting is gaining impetus. Henry Wiggin, for instance, found that vacuum melting moved the optimum alloy content of their later Nimonic alloys for best stress rupture life. With modified compositions and vacuum treatment, they have now progressed to production and have raised the top temperature limit of these alloys by about 50° C. But even an apparently simple advance like this is only the beginning of a great deal more development work in forging techniques, machining, designs, service evaluation and data feedback.

One field where research could bear fruit is in high-temperature elastomers. Viton A and B, made by Du Pont, can be used up to about 250° C and correctly formulated silicones can be used similarly. There is no immediate prospect of developing elastomers going much higher than this, but there would, in fact, be no tonnage uses for such materials even if they were made. The material which takes over from elastomers at the moment above about 250° C is the metal spring or bellows, and with no discredit to new developments, these have been commercially available for decades.

Forecast

Emphasis in materials processing during the next decade is likely to be on technical service. At the moment, there are no signs of revolutionary new processes or materials, but a technica-generalisation of this sort can be deceptive, especially in a time of rapid technical change such as the present.

There is, at present, something of a lull, or rather a slower rate of expansion, in many branches of the chemicals industry while production catches up with new capacity. This process should not take very long, for the country is in the middle of a boom in capital goods whatever may be the problems in the consumer-goods industries. In another year or so, unless there is a sudden worsening of the general economic situation, capacity in the materials-processing industries should start to advance at a more rapid pace.

Management problems are likely to be concentrated on getting sufficient technical and managerial ability trained quickly enough. Old ideas about rigid divisions between academically-trained and works-trained personnel may have to be revised, at least to a limited extent. A policy of advancement *ouvert aux talents* may prove to have decided limitations but it is likely to be tried—with varying success.

As far as can be seen, the materials-processing industries should have no insuperable problems in getting their requirements in steel, machinery, non-technical labour and processing supplies. The world trend in raw materials is downwards so far as prices are concerned, so, for at least a year, one cause of inflationary pressure on costs and inflated inventories is out of the way.

Scientific and Engineering Instruments

Power plant instrumentation, radar and radio astronomy, thickness gauges, medical and aviation instruments, optics, clocks and watches, and cameras.

TO ANYONE who requires his definitions clear cut and precise, the scientific and engineering instruments industry presents a somewhat irritatingly vague enigma in that it has no sharply-edged boundaries. Its activities, the application of its many products, its considerable scope in industry, medicine, aviation, nucleonics and, in fact, in almost all of mankind's activities, cannot be prescribed with absolute accuracy.

The Board of Trade has its own classification of scientific and engineering instruments, but this, extending from engineers' small tools to radar, and embracing precision chains and watches and clocks, hardly helps to clarify the picture.

Design and Development

The turnover of the industry can now be taken as approximately £100 million a year, increasing at the rate of some 7 or 8 per cent, but with that rate of increase itself increasing. It is safe to predict that the two divisions that will be notable for their expansion this year will be those dealing with electronics (see " Telecommunications and Electronics " in ENGINEERING of last week, page 30) and nucleonic instruments. Nucleonics are particularly interesting because not only will there be a considerably increased call for reactor instrumentation, but the use of measuring and control instruments using radioactive sources will most certainly experience an upward trend. This type of instrument owes much of its development to the active, even enthusiastic, spirit of cooperation shown by the research departments of the United Kingdom Atomic Energy Authority. Recently from their laboratories there have come some quite brilliant ideas which will almost certainly make their first impact on the instrument market during the year. The use of radioactive materials for measurement and control is already becoming commonplace, thickness gauges and the use of back-scattering gamma radiation for measuring surface finishes are two techniques frequently employed.

A new application now being developed from an idea that originated at the Atomic Energy Research Establishment is an appliance for the continuous measurement of the variation in thickness of fine threads which is likely to be of interest for the textile industry as a new method of quality control. The thread is bombarded with beta particles and the measurement of the beta absorption is a measure of the thickness. The beta particles are directed at the thread from several angles to reduce the effect of any change in cross-section shape. Because variations in air temperature and pressure would affect the accuracy of the measurement indicated, a second radioactive source and particle detector measures the beta absorbtion in the atmosphere only, providing automatic correction to the thread-measuring instrument.

This type of equipment and another new piece of apparatus which UKAEA has designed, for measuring the ability of a container to prevent the ingress of atmosphere when the quantity concerned is too small to be measured chemically, are examples of the excellent association that exists between government sponsored research departments and industry.

This year there will be millions of pounds spent on atomic power plant instrumentation. The contracts for Sizewell and Dungeness have been placed and the first two of the Central Electricity Generating Board nuclear stations, Berkeley and Bradwell, will probably start operating during the year. The Windscale experimental advanced gas cooled reactor, AGR, which may be the first of a new generation of graphite moderated power plants, will go critical, and there is a great deal of work to be done during the year on the Dragon Project at Winfrith, Dorset, the high temperature reactor being developed as an international effort, backed by OEEC but financed mostly by Britain. There is every prospect that the fast breeder reactor project at Dounreay, which is already in operation but on which development was slowed down because of lack of staff and lack of money, will get fully into stride again. At Dounreay there is already one of the most completely equipped irradiated fuel laboratories in the world, where " hot " uranium, plutonium and thorium, straight from the reactor, can be investigated and put to physical, chemical and X-ray tests by remote control. It is likely, however, that the infusion of more effort at Dounreay will result in a call for more specialised instruments.

AEI electron microscope fitted with image intensifier shown with its display equipment.

Because of its experience in the instrument and control equipment at Calder Hall, British industry has done well in overseas markets with reactor equipment and there is every likelihood of this activity expanding this year. The Italian and Japanese contracts have already been started and this year the Brazilian contract for a nuclear power station will be awarded. There is at least a reasonable chance that this will come to Britain.

In the electronic field one can expect some of the most notable signs of progress during the year. Due to be progressed from the experimental bench to become operational radar hardware is a brilliant development—the parametric amplifier, which under test conditions has already shown that it can increase the range of radar sets by 25 per cent, the equivalent of more than doubling the transmitter power. This is undoubtedly a major radar breakthrough and has other possible applications, including radio astronomy.

Electronic development assumes particular significance because electronic techniques are now incorporated in such a wide variety of instrument and control apparatus. It has become the basis of almost all automatic processes, though some hydraulic systems still retain a degree of support. One group of manufacturers has recently introduced a complete range of airborne equipment using transistors, but only after a research programme which included 20,000 hour life tests on various types of transistor working under exactly the same conditions they would encounter in aircraft.

The instrumentation of aircraft has before it a challenging year which will include the introduction of the first experimental Mach 2 aircraft, the Bristol T188, and the planning of supersonic transports. Modern aviation is a province in which the instrument maker is put to a severe test and in the last few years the degree of instrumentation has become quite remarkable, even by modern engineering standards. Apart from the more obvious requirements, there have been big advances in engine instrumentation which is now almost a process of automatic control in which the pilot (or possibly the autopilot) demands a given output of power and the control instruments attend to all the engine adjustments, equating them with ambient temperature and pressure conditions and taking into account individual mechanical idiosyncracies that may have developed in the engine during flight.

An indication of the type of sophisticated instrument that can be expected is already given in an engine condition analyser which presents to the flight engineer a pictorial display on a cathode ray tube of engine temperature and vibration factors. Temperature is obtained from a number of thermocouples in the combustion system of each engine, vibration is detected by a pair of transducers on each engine. The instrument's value is that it can give advance warning of impending engine troubles. Faulty burning, the damage of a turbine blade or the blockage of a burner can be diagnosed immediately, thus giving an opportunity of preventing a major engine failure. Already the first steps to completely automatic engine control are seen in jet pipe temperature controllers which adjust the fuel flow in direct response to temperature changes, a magnetic amplifier converting temperature signals into mechanical movement of the inlet valves. Any old-time pilot who has juggled with throttle, boost and pitch controls in his effort to get maximum performance while conserving fuel will appreciate the modern achievements.

This year will certainly see developments in one of the instrument engineer's biggest aviation successes—Autoland, the British system of landing an aircraft completely automatically and which, it is to be hoped, will be accepted as an international standard. Autoland is an instrumental triumph, two or three years in advance of any other competitive system, and the result of a fine cooperative effort by the Ministry of Aviation's Blind Landing Experimental Unit (BLEU) and a group of instrument and electronic firms. Immediate development in Autoland will be the replacement of one of its less elegant components, the buried " leader cable " which provides a magnetic field for azimuth guidance to the centreline of the runway. This is to be replaced with an accurate radio beam serving the same purpose. At least two manufacturers claim that their standard ILS (Instrument Landing System) approach beam is already sufficiently accurate for Autoland.

One of Britain's oldest instrument activities has been in the field of optics. Though this country is not a serious competitor in the world's " popular " market for cheap cameras and binoculars (where Japan is now claiming international success) our optical manufacturers retain the leadership in the sphere of high quality specialist lenses. Examples are the marketing

of special camera lenses such as a 2 in focus lens of f/1 aperture, designed specifically for photographic recording from cathode ray tubes. An even wider lens, of 64 mm focus and aperture f/0·71, has recently gone into production for making cine-radiographic recordings where the large aperture allows low intensity X-rays to be used on the patient. In producing lenses of this type, the manufacturers already work to an accuracy of measurement which is within the wavelength of sodium gas.

The refinement of medical instruments has been impressive and after the introduction of such things as the electronic lung, X-ray equipment that reduces the dosage to the patient by 25 times, pacemakers that will keep an unreliable heart beating and silent, vibration-free dental drills, not to mention the British continuous blood-pressure follower which has had such success in America, it would be reasonable to expect the medical instruments industry to consolidate its long list of very new products.

Future Events

During 1961 there are several significant events which, though they cannot be expected to affect the industry materially, will mark progress and pointers to future activities.

We have considered most of the main nuclear milestones of the year, but in aviation there will be several occasions of obvious interest to the instrument engineer. The much-argued subject of supersonic transport aircraft will certainly come in for a share of discussion. In the spring IATA will meet to consider the requirements of supersonic aircraft. The extensively instrumented aircraft, the VC10 and the Airco 121, will have made their appearance, both of them probably carrying the initial (but not complete) equipment designed for automatic landings.

Britain's very small stake in space research, the satellite carrying our instruments but put into orbit by an American "Scout" rocket, will be launched. If any governmental decision is made to launch a combined United Kingdom/Commonwealth/European space programme, the instrument industry will play its part.

With so much interest in semiconductors, the international convention in Paris in February will be valuable as will the international electronic component exhibition, also in Paris in February. The London exhibition of the Radio and Electronic Component Manufacturers' Federation is at the end of May. The June conference in London to discuss components and materials will provide an opportunity for considering that most important aspect—reliability.

In July there is a conference in London dealing with optical instruments and techniques immediately after the London Ophthalmic Optical Trade Exhibition and Conference.

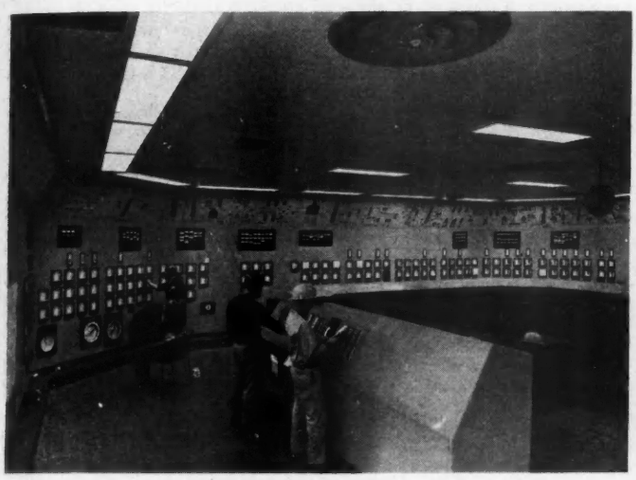
The third international conference on cybernetics will be held at Namur in September. A Bangor conference will discuss radio frequency spectroscopy in solids, also in September next

If the business computer symposium, held in connection with the British Electronic Computer Exhibition in London in October is as successful as the previous one, in 1958, it will provide worthwhile interests for most engineering people.

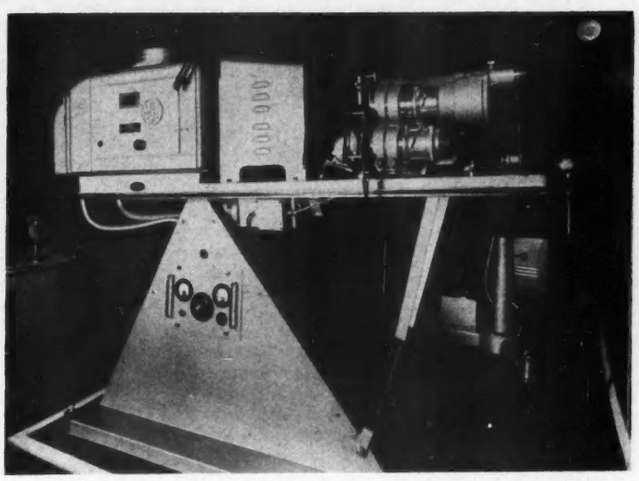
In November there will be a London conference on methods of non-destructive testing in electrical engineering.

External Factors

The coming into effect of the European Free Trade Association is of particular importance to British watch manufacturers. Makers of both clocks and watches are beginning to face stronger competition from abroad as a result of the progressive removal of import quotas and, in the case of watches, reduction in import duties. In the case of watches the main competition is, of course, from Switzerland and since Switzerland and the UK are both members of EFTA the British watch industry is in the long run likely to be more seriously affected than the clock industry, whose main competition comes from West Germany.



(Left) Control room of the Esso refinery at Milford Haven. All the processing can be supervised from this one point.



(Right) Premier xenon slide projector—first of its kind in the UK—in the lecture hall of the Royal Aeronautical Society.

Watches are the only product for which the United Kingdom has obtained special treatment under the convention of the European Free Trade Association and an understanding has been reached between the British and Swiss watch industries. Import quotas for watches with a cif value above £5 were removed as from 1 January, 1960, but the agreement provides for a slower relaxation of quotas on cheaper watches; for 1960, these quotas were increased by only 5 per cent compared with 1959. By 31 December, 1969, all import quotas for watches will be abolished though the special agreement does not affect the import duty on watches. In common with import duties on other products from EFTA countries duty has been reduced by one-fifth (i.e. from 33⅓ to 26⅔ per cent) as from 1 July and further progressive reductions will be made until at the end of ten years the duty will be removed entirely.

The industry has had the advantage of modern plant and the Government's view appears to be that, even if the gradual removal of protection results in a decline in the British output of watches, the steps taken in 1946 will have gained their main object of building up a labour force skilled in micro-engineering.

Market Trends

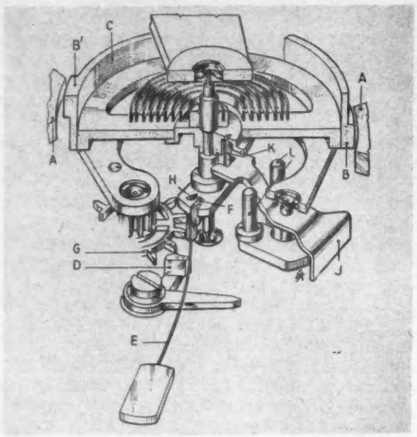
The British market for watches has in recent years proved very inelastic and both production and imports have shown very little change. Over the period 1957 to 1959 production of watches has fluctuated between 2¼ and 2½ million, valued between £3·4 million and £3·6 million. Imports of complete watches in 1957 and 1958 were approximately 1,420,000 but fell to 1,382,500 in 1959. This decline was offset, however, by a rise in imports of movements from 340,000 in 1958 to 390,000 in 1959.

In the first eight months of 1960 production was running at the rate of 2¼ million valued at £3·1 million, which may indicate that either manufacturers have already been forced to reduce prices in order to meet the reduction in import duty or that the proportion of high grade watches produced has fallen owing to the removal of import quotas. In the first nine months of 1960 imports of complete watches rose to an annual rate of 1,530,000 and of watch movements to 494,000. Between 1959 and 1960 the average cif value of complete watches imported fell from £1 12*s* 0*d* each to £1 11*s* 0*d*. It therefore appears that the increase in imports was due mainly to the relaxation in the quota on cheap watches rather than to the removal of that on the more expensive types.

British exports of watches are available by value only and are included with parts of watches and clocks, including the glasses. They rose from £682,000 in 1958 to £885,000 in 1959 and an annual rate of £1·1 million in the first nine months of 1960.

A review of the world production of watches appeared in the issue of ENGINEERING for 8 April, 1960 (vol. 189, p. 474). This brought out some significant changes in the relative importance of the principal producing countries. While the share of world production accounted for by the USA declined from 25·0 per cent in 1937 to 9·2 per cent in 1957 and that of Switzerland fell from 51·0 per cent to 48·3 per cent, the share of the United Kingdom rose from nil to 2·9 per cent, that of the USSR from 1·4 per cent to 16·4 per cent and of Japan from 2·0 per cent to 4·0 per cent. Imports of watches into the UK from both the USSR and Japan are controlled by quota, but in March, 1960, the first samples of Russian watches appeared in this country following the trade agreement of 1959 which permitted the import of such watches up to a value of £33,000. These watches are reported to have been of good quality and finish.

In the case of clocks the position is rather different since as already stated the main competition in this field is from West Germany. Following the assistance given to the industry in 1946 the British output of clocks rose to 5·8 million in 1959 (of which 5·0 million were mechanical and 0·8 million electrical) valued at £5·6 million. British output is now larger and



Balance-motor assembly in the Lip electric watch.

more diversified than that of Switzerland and approximately one-fifth of the output by value is exported. Quotas on imports of clocks were removed in November, 1959, and imports rose from 841,700 valued at £753,000 in 1959 to an annual rate of 1,427,000 valued at £1,267,000 in the first nine months of 1960.

In regard to clocks there is no special provision to delay the full impact of trade liberalisation and already this country has lost its position as a net exporter of clocks. However, the increase in imports has not yet been reflected in any fall in UK production which, in the first eight months of 1960, was running at 5·7 million. There has been a small increase in production for export from an annual rate of £1·1 million in 1959 to £1·2 million in 1960. The next few months should show whether the British industry will succeed in maintaining home sales in the face of the removal of import quotas.

An interesting development during the past year has been the introduction in the UK of electric wrist watches. It was announced in August that Ingersoll were to become the sole UK representatives for electric watches made by the Hamilton Watch Company of Lancaster, Pennsylvania, while at the same time it was stated that Louis Newmark were to market an electric wrist watch made by the Swiss Avia Company. Both types were exhibited in September at the Watch and Jewellery Fair at Olympia. Descriptions of these watches were given in an article in the issue of ENGINEERING for 9 September, 1960 (vol. 190, p. 339) and the illustration above is reproduced from the *Horological Journal*.

In the manufacture of clocks and watches many attempts have been made to devise systems approximating to perpetual motion and thus to produce clocks which will operate without attention for very many years. The development of modern instruments has considerably widened the possibilities in this field and it was announced last year that a Swiss watchmaker is starting quantity production of a clock fitted with a photo-electric cell which transforms light into sufficient electrical energy to operate the movement. It is hoped eventually to reduce the size of the mechanism for it to be used in wrist watches.

For several years the output of scientific instruments has been expanding considerably more rapidly than that of the economy as a whole. The past year has been no exception to this and there is every reason to believe that expansion will continue this year. Owing to the wide range of instruments involved and the variety of industries responsible for their manufacture it is extremely difficult to obtain an overall statistical index of progress. However, the figures published by the Board of Trade for the first time in 1959 covering deliveries of certain scientific and industrial instruments and apparatus on a quarterly basis continue to provide a useful indication of progress in several branches of the industry. These figures also include computers which will be covered in this series in "Information Processing and Business Equipment" (20 January) and will therefore be omitted from consideration here.

The most important subdivision of the industry shown in these statistics is Industrial Process, Measuring and Control Instruments (including water supply meters) of which production in the first six months of 1960 was running at the rate of £42·4 million per annum, an increase of 15 per cent compared with the previous year. Production for export showed a rather larger percentage increase but since exports account for only about 25 per cent of total production, the rise in output reflects mainly the continuing progress of automation and instrumentation in British industry.

The next most important subdivision of the industry comprises Nautical, Aeronautical and Gunnery Control Instruments, of which output has tended to decline in recent years, falling from £12·6 million in 1957 to £10·7 million in 1959. However, this decline came to a halt in 1960 and deliveries in the first six months of the year totalled £5·6 million, compared with £4·7 million in the corresponding period of 1959. Deliveries of optical instruments, other than ophthalmic appliances rose from £5·9 million in 1959 to an annual rate of £6·8 million in 1960 and those of electrical measuring instruments (excluding supply meters and instruments for motor vehicles) from £6·5 million to £7·0 million. For all the categories listed above, deliveries rose from £59·9 million to £67·6 million, an increase of 12·8 per cent. Another related industry which has also shown a steady increase in output is that producing engineers' small tools and gauges. Total deliveries in the first six months of 1960 were running at the rate of £63 million p.a. compared with £52·1 million in 1959 and £51·6 million in 1958.

British instrument manufacturers have also achieved considerable success in export markets. Owing to the number of different categories involved the figures are best shown in the table.

There has thus been a steady progression of exports with a rise of about 11 per cent between 1959 and 1960. Countries of destination are not available in detail for the various categories shown above but taking all scientific instruments, photographic and optical goods, as well as clocks and watches (but excluding all types of electrical instruments) the most important markets in 1960 were Australia, the USA, Western Germany, India, Canada, France and the Union of South Africa.

The instrument manufacturing industry will probably feel any recession in exports in 1961 much less than most other branches of industry. The long term trend in the demand for most types of instrument is so strongly upwards that any recession in world trade as a whole is likely to be reflected in a slowing down in the rate of increase in the value of exports of instruments rather than in a decline in those exports. Western Germany and France are among the most important export markets and substantial orders have recently been received is the USSR. Honeywell Controls Limited, for example, received an order during 1960 valued at £200,000 for instrumentation for a Russian chemical works and it has been reported that sales by Solartron Limited in Russia in 1959 exceeded £300,000.

Management and Labour

The labour force employed in the production of scientific, surgical and other instruments (excluding electrical) has been increasing steadily and rose from 114,900 in July, 1959, to 120,300 in July, 1960. Over the same period employment in the manufacture of watches and clocks rose from 14,500 to 15,700. Owing to the wide range of products made and the fact that production statistics are not complete, it is not possible to compare accurately the trend of output with that of manpower employed in the industry. If, however, the production statistics quoted above, which showed an overall increase in deliveries of 12·8 per cent, are representative of the industry as a whole, it is clear that there has been a substantial increase in output per employee since the increase in the labour force between 1959 and 1960 was only 4·7 per cent.

Though the total manpower engaged in the production of instruments and of clocks and watches represents only about 6·7 per cent of total employment in the engineering industries (including electrical engineering) it comprises a high proportion of highly skilled labour which is of great importance to the country both strategically and in relation to the future trend of exports.

Plant and Materials Supplies

The scientific, surgical and photographic instruments industry and the watch and clock industry are not large users of raw materials on a tonnage basis, and are not normally troubled by shortages of materials supplies. On the basis of value, photographic paper and photographic film base are important raw materials, as also are silver and silver nitrate, rubber in all forms, aluminium, optical glass, power lenses and certain plastics components, but in no case is consumption by instrument manufacturers a major factor in the total market for these materials.

Expansion and Investment

The continued expansion in the output of instruments has been accompanied by a steady consolidation of the leading companies in the

TABLE:—*UK Exports of Instruments, 1958 to 1960* (£000).

	1958	1959	1960*
Ophthalmic instruments and appliances:			
Frames and mounting and lenses for spectacles, etc.	380·6	530·5	562·1
Others	240·4	197·7	203·5
Optical instruments and appliances (including lenses) and parts	1,497·2	1,358·1	1,377·7
Photographic and cinematograph instruments and appliances (see graph A):			
Complete:			
Box cameras (excluding precision cameras)	126·5	154·4	125·3
Other cameras including cine cameras	806·6	1,200·1	845·7
Cinematograph, etc., projection apparatus:			
Cineprojectors other than standard 15 mm gauge	670·6	548·0	592·3
All others	289·7	228·6	277·3
Other cinematograph appliances and parts	949·7	926·4	811·1
Lenses and other optical elements for photographic and cinematograph use and other photographic appliances and parts n.e.s.	1,734·2	1,747·9	2,187·3
Medical, surgical, dental, veterinary and dissecting instruments and appliances and parts (see graph B)	1,058·6	1,127·7	1,162·9
Other sorts	1,182·9	1,292·7	1,483·9
Other measuring, controlling and scientific instruments and parts (excluding optical):			
Aeronautical instruments and apparatus	2,068·7	2,596·8	2,550·3
Engineering and industrial:			
Precision measuring instruments and machines	1,301·0	1,562·0	2,044·4
Pressure gauges, recorders and controllers	1,285·6	1,619·3	1,845·1
Others	843·8	1,100·9	1,216·0
Flow measurers and controllers	542·4	754·6	983·2
Gas meters	348·4	359·2	365·9
Nautical instruments and apparatus	1,276·5	1,297·5	1,286·5
Surveying instruments and apparatus	562·0	430·9	429·5
Thermometers and meteorological instruments	767·9	757·2	760·5
Water meters	1,073·9	1,075·3	1,177·9
All others	4,989·6	5,608·9	6,529·3
Electrical instruments, commercial (excluding telegraphic and telephonic but including ammeters, voltmeters, etc., and parts) (graph C)	2,085·0	2,042·9	2,343·9
Electrical house service meters including parts	1,766·2	1,684·1	1,806·1
Electro-medical apparatus (excluding deaf aids, X-ray apparatus and batteries) (graph B)	600·0	402·8	540·0
X-ray apparatus (excluding tubes and valves)	600·4	591·7	629·5
Scientific electrical instruments (excluding telegraphic and telephonic, time recorders and time switches (graph C)	4,311·7	4,206·8	5,182·1
Total of above	33,360·1	35,403·0	39,339·3

* Based on first 9 months of the year.

"Modern aviation is a province in which the instrument is put to severe test." Cockpit of a Vickers Vanguard.

industry and a number of amalgamations between producers. One factor has undoubtedly been the need for access to substantial capital in order to undertake expansions to capacity.

Among the more important developments along these lines may be mentioned the acquisition of a 52 per cent interest in Solartron by Firth Cleveland; the mergers between the Cambridge Instrument Company Limited and Electronic Instruments Limited, and between Ether Limited and Langham Thompson Limited; the purchase of majority interests in Kelvin Hughes by S. Smith and Sons Limited, and in R. J. Beck by Griffin and George; and the acquisition of S. G. Brown by the de Havilland Aircraft Company Limited, of Infra Red Developments Limited by Hilger and Watts Limited, and of the Rheostatic Company Limited by Elliott-Automation Limited.

Following the acquisition of Kelvin and Hughes, Smith announced the formation of a new division to integrate its business in industrial products and combine the manufacturing activities in the field of industrial instruments of Smith's Industrial Instruments Limited, Kelvin and Hughes (Industrial) Limited and David Harcourt Limited. The effect of these and other mergers has thus been to build up a few large companies whose interests are mainly in the field of instrument production and automation and to bring a number of other manufacturers under the control of groups whose main activities are in other, but often related, fields.

Some 24 British manufacturers exhibited at the Second International Congress and Exhibition for Instruments and Automation (Interkama) which was held at Dusseldorf from 19 to 26 October, 1960, where a community stand was arranged jointly by the Board of Trade and the Scientific Instrument Manufacturers Association. The total number of exhibitors was about 420 and although the number of exhibitors is by no means the best measure of the importance of a national exhibit, the international importance of the British instrument manufacturing industry would perhaps have justified a larger representation. The exhibition is to be held every three years.

British instrument manufacturers have in fact, made a number of agreements with overseas producers; towards the end of last year, for example, it was announced that Elliott Brothers (London) Limited were to manufacture certain valves under licence from the General Kinetics Corporation, Englewood, New Jersey, and that the latter would have exclusive rights for distribution and servicing of certain products of the British company in the Western Hemisphere. It is understood that one of the main objects of the agreement was to provide an outlet in the USA for control valves and regulating equipment produced by Black Automatic Controls Limited, a recent acquisition by the Elliott Group, and certain products of James Gordon Valves Limited.

Ether Langham Thompson Limited have established a new subsidiary, Ether Langham Thompson (Italiana) Limited, with a factory in Milan to manufacture and market the products of the company and its subsidiaries. The Italian company will also act as agent for a number of other British instrument manufacturers. In the reverse direction R. B. Pullin are selling in the UK industrial process control equipment designed in Italy by the Sta. Guardigli of Milan.

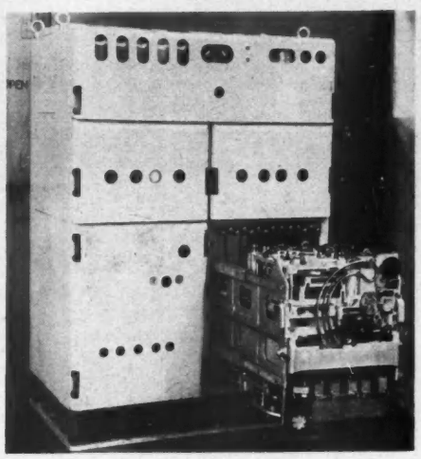
Long Term Research

An advantage of consolidation of the industry that has come about with the company mergers mentioned above is that it will help the industry to finance the extensive research and technical development necessary if it is to maintain its lead over foreign competitors. At the present time, with the possible exception of the USA, the British industry is probably more advanced than any other, though German manufacturers, hitherto handicapped by a slow start after the war, are now making every effort to close the gap. In spite of the trend toward amalgamation, however, this is an industry in which there will continue to be full scope for smaller companies in the development of new ideas.

Steps were taken during 1960 to improve the research facilities available to British instrument manufacturers by the erection of a new building at the headquarters of the British Scientific Instrument Research Association at Chislehurst. The new building comprises new workshops and mechanical laboratories and provision has been made to accommodate more specialised equipment and precision machine tools.

In the field of optical instruments, an optical design group was set up last year at the Imperial College of Science and Technology with the support of a long-term grant from the DSIR. It was stated that the main aim of the research will be to develop new methods of lens design, to construct lens systems of improved performance and to develop specialised lens systems required in very limited numbers, such as those used for space research.

The year may well see very interesting results from Imperial College, where the team, led by Dr. C. G. Wynne, possibly one of the greatest theoretical experts on lenses, is studying particularly the application of computer techniques to lens design. Computers have been used for this purpose before but the techniques employed are known to be imperfect. The object of Dr. Wynne's work is to simplify the programming and to correct some of the known inconsistencies of design in order to find a computer formula which will provide a mathematically perfect lens for any given application. As the optical manufacturers say, their aim is to get as near absolute perfection as present methods allow and then improve existing techniques.



An electro-mechanical computer for naval anti-aircraft gun-fire control, designed and made by a division of Elliott-Automation.

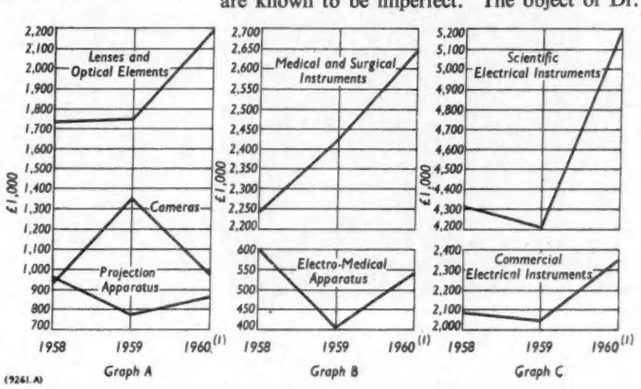
It is worth mentioning, however, an extremely interesting research project that has been undertaken under the auspices of the Council for Research into Apparatus for the Disabled and the National Fund for Polio Research which could come to fruition this year if all goes well. It is the development of artificial muscles in the form of small compressed air actuators which are controlled directly by the small voltages produced at the nerve ends when a "message" travels from brain to muscle. Even though the muscle itself is destroyed, it is generally found that when the brain orders it to contract, the necessary—though extremely small—voltage will be produced. These impulses are to be amplified to produce the controlling element of the compressed air actuators. Because the amplifiers are dealing with input signals in the microvolt range, they have to be extremely sensitive and this itself is introducing problems because of the tendency of the control systems to pick up unwanted interference.

Forecast

For the scientific and engineering instruments industry all the signs are unmistakably healthy. The steady progress in the development of improved techniques and the increased need for instrumentation in modern processes can be reasonably expected to give another year that will satisfy the directors of both the technical and commercial departments.

However broad the picture, the trends for 1961 can be based on the assumption that the industry will continue with its successful theme of the past few years. There must be a continuous flow of material products of the highest quality but, even more important, there must be a constant flow of ideas and progress.

Possibly one of the most significant fields of progress in 1961 will be the expansion of automatic processes in industry, in which Britain has lagged conspicuously until recently. This is an excellent example of intimate association: every step towards greater automation is reflected in greater demands made on the instrument industry; conversely, progress by the instrument makers in developing new control systems influences their adoption by industry. It can be looked upon as a form of bi-directional feedback! Supplying a product for which there is a demand is one thing; devising a product that will stimulate a demand is possibly more important, and it is in this way that the instrument makers can best increase their contribution.



Graphs A, B and C. Exports of various types of instrument. The data are taken from the table opposite.

(1) Annual figure based on first nine months of 1960.

Civil Engineering and Building

Rain—droughts and floods—dams, structural analysis, quarrying, housing, tenders, roads, heating and ventilation, mining and bridges.

THE potential for civil engineering is enormous, particularly overseas, wrote Mr. W. G. Mitchell, the president of the Federation of Civil Engineering Contractors, recently. The schemes for the Indus and the Volta River dams were a foretaste of what was to come. But, he continued, great vision and enterprise, backed by Government finance, would be required to grasp these opportunities, and as yet there was little sign that adequate help from the Government would be forthcoming.

At home there is a danger that the construction programme may be getting out of phase. Overloaded sewers require to be supplemented, rivers and beaches still have to be freed from pollution and the transport system further modernised. The severe drought of 1958-59, followed by the heavy rains of the year 1960—and the subsequent flooding—has disclosed the need for work by the river and catchment boards. Housing and general building, however, are the predominant commercial factors for the two industries.

Design and Development

The weather, particularly rain, and the severe industrial fires of the last two or three years are going to have a notable effect on civil engineering design. So far as fire protection is concerned it is not the endurance of materials that is a fault—or lack of knowledge about the fire properties of constructional materials, for all the basic data have been collected and have been widely published—but greater thought must be put into the design of the building so that fires may be more speedily detected, isolated or confined, and finally suppressed. Better ventilation, and more air conditioning, may well provide conditions that reduce the likelihood of fires, but care must also be taken that these same improvements do not, in the event of a fire starting, cause it to spread even more quickly.

The real difficulty that lies behind the water shortages of 1959 and the flooding of 1960 is not merely the failure to provide the requisite installations—given the necessary capital, this is rarely a problem. Both the droughts and the flooding are partly due to a lack of knowledge of the run-off and yield from a catchment area and improvements are required in the basic methods available for procuring this information. Only then will it be practicable to design economic river training works. Given good data then better use of hydraulic models will be possible and, as the point was made in this series last year, it is the use of these models for works of the type coming before local authorities and river and catchment boards that has been a notable feature of recent years. In this connection it is worth noting the work George Wimpey are doing at their hydraulics laboratory at Southall. This commercial enterprise is well equipped to tackle many hydraulic problems. To date they have been getting work from various consultants, and they are catching some of the commercial work that might otherwise go overseas, particularly to Grenoble and Delft.

The keynote of many contractors' advertising and publicity this last year has been their claim to complete work on or, better still, before the expected date. Good project planning is essential in such cases and the civil engineer has been absorbing a lot from his brother production engineers about material flow, material handling, the economic disposition of labour, the introduction of mechanisation—can automation follow?—and, generally speaking, what were forward planning charts a few years ago are now instruments of control. Indeed a measure of the change that is taking place is the wide acceptance of control techniques by the average contractors' engineer so that there is no longer the same need for the project engineer who works as a specialist within a service department.

Greater efforts, too, are being made to take the contractors' point of view into account at an earlier stage than has been the practice in the past. To do this is not necessarily to criticise the work of the consultant who, though a design specialist rather than an erection expert, is usually well versed in site techniques. Nor does it necessarily imply packaged deals with the contractor doing all the design, construction and his own inspection with no one on the side of the client. There would appear to be room for method to be evolved whereby the tender would be issued and awarded at a much earlier stage than has so far been customary, without making any pretence to produce what purports to be finished detail designs which frequently have to be amended as the work proceeds. With the appointment of the contractor, detailing could then go ahead paying particular regard to the methods and equipment that he is able to employ.

The approach to aesthetic treatment of structures is now broader than the mere architectural treatment of the structures. Landscaping is now the watchword. Last year several papers were read before various institutions dealing with the problems of landscaping modern trunk roads and, elsewhere, the treatment of reservoirs was examined. Fortunately the beauty of a stretch of water was recognised and suggestions were put forward for improving the uninteresting appearance of large artificial embankments by planting a variety of grasses and shrubs.

Housing and general building is, and will remain, the staple interest of the civil engineering industry as well as the building industry.

Power stations and processing plant generally can make a big impact on rural scenery but a lot of lessons are to be learnt from the successful completion of the Esso refinery at Milford Haven. The site has the potential for the refinery to be expanded until it is among the largest in the country, but by careful choice of site, with the buildings and plant located in a hollow, by using a ground flare rather than a stack, and by retaining a substantial area around the site for farming and company amenities, every effort has been made to minimise the effect of the refinery on this unspoilt coastline. Tree screens are also to be planted if this is practicable but the high winds and poor soil of the region may render these efforts worthless.

New materials continue to be introduced and plastics still obviously form a largely untapped source for further developments, offering particularly a low weight and a long life with their high resistance to corrosion.

In the field of structural analysis, the basis of all structural design, there has probably been no outstanding development since about 1954, except perhaps for the adaptation of shell theory to suit the requirements of roof designers.

Since 1954 or so, however, there has been much activity in the application of digital computers to structural problems concerned with both elastic and ultimate plastic behaviour. Many structures—and the new Hammersmith Flyover with its many continuous spans is a good example—have been designed with the aid of computer techniques. What is more important, however, is the reappraisal of conventional structural analysis during the last six years. The use of stiffness and flexibility coefficients for linear analysis has become widespread in academic circles and energy principles have been stripped of their mystery. It will necessarily be some years before new graduates can carry their broader knowledge into industry but we might then see the real significance of the plastic theory appreciated and used in day to day analysis with substantial advantage.

Future Events

Will the Governments of Great Britain and France say yes to a Channel Tunnel? Permission to go ahead would see the start of the biggest project ever begun here. Even more necessary is Government approval for London Transport's Victoria Line, the new tube that could so much relieve London's internal passenger transport problem. Commencement would mean the beginning of the largest tunnelling contracts let in this country for 50 years. Either scheme would give a great impetus to the precast concrete industry, for both tunnels would be lined with prefabricated concrete sections—not that this particular industry is without work for it has expanded enormously over the last few years, contributing much to the rapid erection of many multi-storey buildings.

The largest scheme in hand in the United Kingdom, leaving aside combined works for railway modernisation and new trunk roads, is the Forth road bridge, which will be the largest suspension bridge outside the United States. The coming year will see the completion of the towers and possibly also of the spinning of the main cables and even a substantial start made on the erection of the deck girders. With this work advancing well the Government have already said that construction will begin on the Severn bridge. Work on the piers and anchorages can be expected to start during 1961 so that as the facilities of the ACD group become freed from the Forth bridge they will be available for the Severn. Completion of these two major projects in 1963 and 1965-6 respectively will be evidence to the world that the UK is still able

to compete for the largest steel bridges. On the concrete side progress on the Medway bridge will be further evidence of the lead this country has established in the exploitation of prestressed concrete.

Overseas, two major dam contracts to be let in the coming year are the Mangla dam, forming part of the Indus project, and the Volta River dam in Ghana. Both these dams will be earth and rock-filled dams and in both cases British contractors are forming part of consortia bidding for the work. Subsidised tenders by contracting groups from the continent will make the going stiff for the British firms and their American friends.

Back here at home the first International Construction Equipment Exhibition is to be held at the Crystal Palace in London during June under the joint sponsership of the Federation of Civil Engineering Contractors, the Federation of Manufacturers of Construction Equipment and the National Federation of Building Trades Employers. It is believed that this is the first time that two major user organisations have cooperated with the manufactuters' organisation in the sponsorship of an international exhibition. Equipment from all the major producing countries will be on show and all the indications are that the exhibition will be the largest of its kind yet held in this country.

At the end of June the Large Dams Congress of the World Power Conference will be holding their next meeting in Rome. A particularly important topic to be discussed, bearing in mind the very large dams that are projected in the next few years, is that of seepage through the bedrock under the dams. At Aswan, for example, where the Russians are beginning their work on the Nile for the Egyptians, the anti-seepage blanket on the up-stream side of the dam has been dispensed with and reliance placed on the clay cut-off skirt that, at the centre of the river, has to reach to a depth of no less than 750 ft below the river bed to the rock below. Only the fullest discussion of all available experience can produce the techniques to make the High Dam a success.

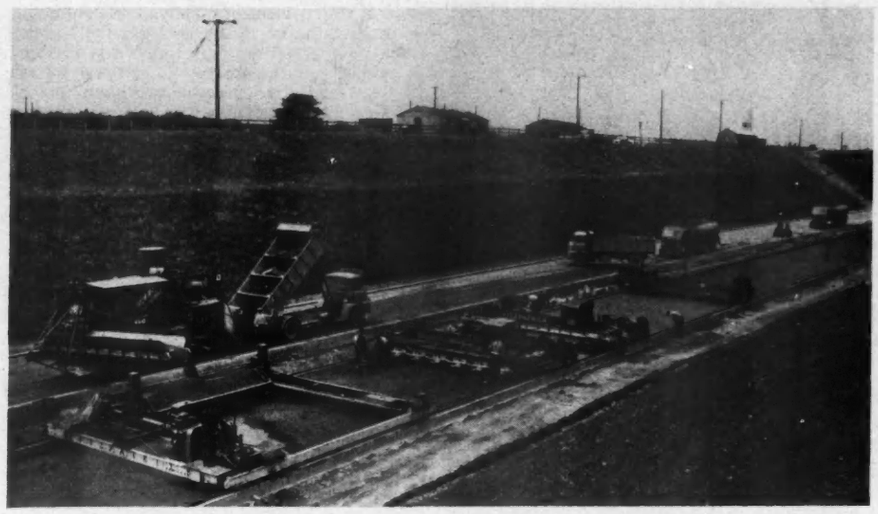
A complementary meeting will be held in Paris, also during July, when the International Society of Soil Mechanics and Foundations Engineering hold their fifth international conference. Six principal questions are to be discussed ranging from soil properties and field measurements through foundations and earth pressures to the stability of earth dam slopes.

External Factors

It will be surprising if the year 1961 is as prosperous for the building and contracting industry within this country as was 1960. By the end of October, 1960, there were 1,107,000 operatives employed by contractors on construction work of all kinds, the second highest level which has yet been experienced. Activity both in housing and industrial work was at a high level, the only decline in value of work done compared with a year ago being in new work for public authorities. This was to be expected since the investment programme of public authorities has been slowed down somewhat by the credit squeeze. So far as the level of industrial building is concerned, there were 808 new projects approved by the Board of Trade in the second quarter of last year, compared with 620 projects in the same period of 1959. There had, however, been a fall compared with the first quarter of 1960 when there were 996 new schemes approved. In terms of square feet, the number of schemes approved in the first quarter of 1960 was just over 34 million and in the second quarter just over 20 million. Orders obtained by contractors for new work declined in value in the second quarter of the year compared with the first quarter. In other words, the work in hand was at a peak, but the volume of new orders had begun to tail off. (See Graph A, p. 80.)

Reference must be made at this point to the future for mining machinery in this country, especially for the coal industry. British mining machinery manufacturers have already had to adjust their outlook to the revised investment programme for the coal industry, published in the National Coal Board's pamphlet "Plan for Coal."

The outlook for the coal industry, and those industries which depend on it for some of their business, has slightly improved in the last twelve months. The improvement in industrial activity over the latter months of 1959 and the early months of 1960 was more beneficial to the consumption of oil than it was to that of coal. Nevertheless, the coal industry has begun to reduce its enormous stocks.



Sufficient road plant is available for the road programme but new projects must be phased so that it can be effectively mobilised. The photograph shows the concrete train on the Doncaster bypass.

Market Trends

So far as the building and contracting industry was concerned, one cause of the lull in new orders was the end of some major building programmes and alterations schemes in the retail trade. But other surveys, such as the Federation of British Industries periodic survey of business sentiment, showed that, as 1960 progressed, there was a slight disinclination on the part of companies to undertake new building programmes on a large scale. Much of the investment undertaken in the last few months of 1960 was for new equipment to go into buildings already built or nearing completion. The boom in capital equipment has continued, but the emphasis has been on machinery rather than on buildings.

The following table, based on the 1954 Census of Production, shows the main divisions of activity in the building and civil engineering industry.

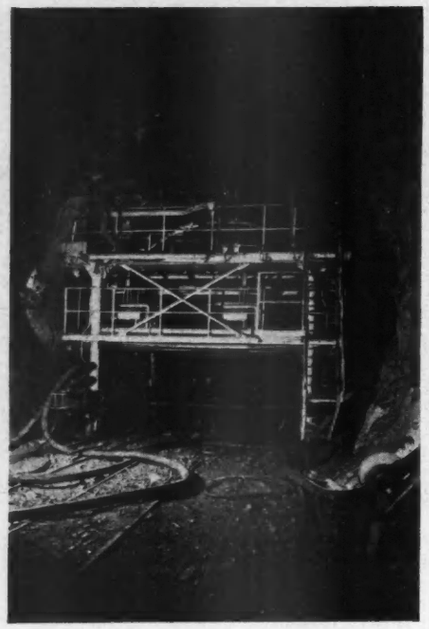
TABLE I:—*Main Divisions of Output of the Building and Civil Engineering Industries*

Industry	£ million	£ million
New housing		215
Housing repair work		491
Work done by central and local Government		13
Opencast coal operations		51
New construction and maintenance on:		
Roads	28	
Airfields	30	
Harbours	18	
Public utilities	114	
Miscellaneous	18	
		708
Factories and warehouses		160
Hospitals and church		79
Stores, offices, hotels		95
Maintenance (misc.)		120
Sub-contracting		153
		1,585

In the last six years the emphasis has altered to some extent but not basically. The main changes have been the decline in importance of open-cast coal operations and construction of airfields. Items which have increased are buildings for factories and warehouses and the road programme. It is broadly true, however, that housing activity, either in new buildings or repairs, remains the single largest category affecting the prospects of the building and contracting industry as a whole, and in this respect it is significant that the largest British contractors all have heavy commitments in the housing programme. After that comes certain kinds of construction and maintenance work on public services such as roads, harbours and public utilities, followed by private investment in factories and warehouses. Fortunately for the building industry, the outlay on new houses and repair work to existing ones continues to run at a high level and is likely to do so in the forseeable future.

Owing to credit restrictions and limitation by the Government of investment by nationalised industries and local authorities, the building and contracting industry is dependent for further expansion in the immediate future on the level of private investment in factories and warehouses. There are, however, two exceptions to this. For some time to come it is likely that the road programme will get special treatment compared with other forms of public capital expenditure. The effect of the road programme on the building and contracting industry and on the demand for excavating plant and building materials, which is discussed below, makes it clear that roads may play an important part in the next year or two in deciding the level of activity in the industry. The other factor is water—droughts on the one hand, and floods on the other—and the Minister of Housing and Local Government has declared that we may be on "the threshold of epoch making changes in the developments, use and control of water."

The latest figures for the earnings of UK contractors abroad do not go beyond March, 1960. Nevertheless, so far as they go they are encouraging. Total value of contracts obtained in the year ended March, 1960, was estimated to be £131 million compared with £114 million in 1958/59. There was a significant increase in the work obtained in the sterling area and in the dollar area. The level of new contracts obtained in Australia and Canada was particularly encouraging. It cannot be assumed however, that this level of activity can be maintained indefinitely. The dollar area is suffering to some extent from the current US recession, and both Australia and Canada are likely to curtail the level of investment in the near future. In the Union of South Africa building work has come to a virtual end, accommodation now exceeding demand. Canada is suffering from balance of payments difficulties which will probably necessitate a curtailment of capital investment, while Australia is on the verge of a further bout of inflation which will also bring into operation counter-measures likely to limit invest-



Drilling gantry on the Inverawe tunnel where new techniques have effected considerable economies.

ment in new building. It may be some time before the level of new orders begins to affect the current level of construction and therefore any pause there may be in the overseas earnings of UK contractors is more likely to be felt in 1962 than in 1961. But for the lack of foreign capital there would be a vast volume of work throughout South America, the Indian sub-continent and Central Africa.

The demand for space heating, ventilating and air-conditioning machinery continues to increase. In 1958 deliveries in the home market were about £35 million and had increased to £38 million in 1959. In the first half of 1960 deliveries were at about £21 million which suggests that there will be a useful increase for the year as a whole. The trend is certain to continue upwards. Air-conditioning engineers are being increasingly called in for the erection of new buildings and factories. Managements are increasingly aware of the importance of clean air and adequate ventilation, while the use of materials, such as obnoxious chemicals, is making it increasingly obligatory to pay attention to ventilation. New office blocks place a premium on good lighting throughout the building with the result that central open staircases are increasingly unfashionble. This is leading to the adoption of other ways of providing good ventilation, and this, in turn, is increasingly being dealt with as one aspect of good space heating. Old offices and factories are also having their ventilation and space heating plants improved as the general standard rises and operatives become increasingly sensitive about working conditions—a state of affairs likely to last as long as there is full employment, which means indefinitely.

The attractiveness of the UK market for air-conditioning equipment however, has not gone unnoticed elsewhere. It seems probable that imports have increased substantially, Unfortunately the trade returns put air-conditioning machines along with refrigerators and refrigerating equipment which obscures the trend. If these two groups are taken together, for lack of any alternative data, imports in the first half of 1959 were just on £400,000 while in the first half of 1960 they had increased to about £666,000. Exports declined slightly. Air-conditioning machines (excluding fans) accounted for £194,000 in the first half of 1959 and for £177,000 in the first half of 1960.

Management and Manpower

Reference has already been made to the high level of employment in building and contracting in the autumn of 1960. In 1961, the building industry will start not only with a record labour force, but with the prospect of a 6 per cent rise in wages and a reduction of two hours in their working week. This was agreed between employers and the unions in the middle of December, 1960. The offer was made by the employers after protracted negotiations and comes into force in October, 1961. It will cost the building industry about £60 million in a full year.

In many countries the term "construction industry" covers both civil engineering and building; but here their industrial separation has some influence upon the receptivity of the building industry to the results of research as well as being a source of possible demarcation problems on sites, such as large buildings, where the two industries meet. On the trade union side the overlap is fairly considerable, but on the management and professional side several distinct, and even competing, organisations are involved.

This industrial separation of building and civil engineering in this country deprives the ordinary builder of many of the benefits arising from the scientific and technical liaison existing between civil engineers and civil engineering contractors, which is much closer than at present exists between architects, quantity surveyors and builders. Civil engineering by virtue of advances in engineering science and design is not so tied to tradition as building. These several points were elaborated by Dr. C. A. Hart in "Getting Research Over to the Builders" (ENGNG., vol. 190, 11 Nov. '60, p. 645). From the arguments Dr. Hart put forward there seems a clear case for unification of the two industries.

Plant and Materials Supplies

Reference was made in the first of the articles in this series (ENGNG., 6 Jan., p. 26) to a forecast made by the National Federation of Building Trades Employers of the demand for building materials in 1961 and comments have already been made on the future demand for bricks. A wider forecast, however, includes other building materials, and covers requirements for the road programme. Compared with deliveries in 1960, deliveries in 1961 are likely to be increased as follows: cement by 3 per cent, plasterboard by 7 per cent, concrete roofing tiles by 4 per cent, aggregates (including building sand, concreting sand, and gravel) by 3 per cent, and metal windows of all types by 3 per cent. It will be noted that the typical rate of increase in the current year is expected to be of the order of 3 per cent. These are the bulk materials, the demand for which is influenced mainly by housing and industrial building. Though the effect of the road programme has been allowed for in the figures, there are one or two other building materials not included in this list which may be particularly affected by road works, both technically and commercially.

The most important of these materials is asphalt. Sometime in the next five or ten years it is likely that the struggle between natural and "synthetic" asphalt will be resolved. At the present time "synthetic" asphalt (produced from petroleum) is gradually overtaking natural asphalt. It is possible that synthetic ashpalt will make further advances in road-making and other uses and that the demand for natural asphalt will settle down at a lower level. The probability of a wholesale replacement of natural by synthetic asphalt does not seem likely at the present time—but it could happen.

The home market demand for steel reinforcement is likely to increase from 450,000 tons in 1959 to 800,000 tons in 1965. This estimate, by the Reinforced Concrete Association's Committee on Steel Supplies, has been communicated to the British Iron and Steel Federation, and to the Iron and Steel Board. The estimates year by year are given in Table II.

TABLE II:—*Expected Growth in Bar Reinforcement*

		Thousand tons
1959	Actual deliveries	450*
1960	Estimated deliveries	600
1961	Estimated requirements	640
1962	" "	680
1963	" "	720
1964	" "	760
1965	" "	800

* Compiled by the RCA from *Iron and Steel Monthly Statistics*

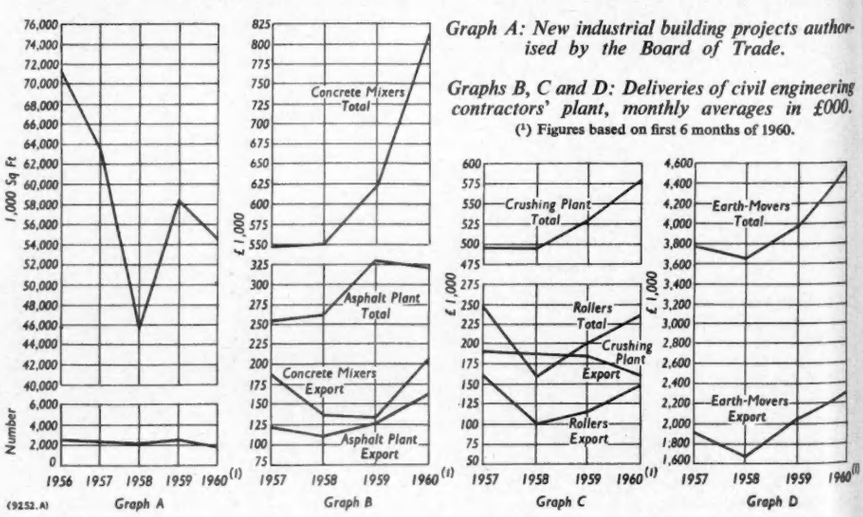
These estimates were made early in 1960 and it now seems likely that the estimate of 600,000 tons for 1960 will be appreciably exceeded.

Some of the reasons for the exceptionally fast growth in demand, are:

(1) With the higher cost and reduced availability of land tall buildings are called for;
(2) The use of reinforcement in bridges and in civil engineering work generally is rising fast;
(3) There are new developments in the use of lightweight reinforced concrete; and
(4) In the ratio between tonnage of reinforcing steel used and population, Britain stands well behind some continental countries.

It is of interest in considering the long term prospects of building materials that Thomas Tilling Limited, the large industrial holding company, has acquired over the last year assets in Scotland, consisting of quarries, sand gravel pits, mineral rights and brickworks through the purchase of the Houston Quarry Company. Certain ready-mix concrete plant and transport has also been acquired by Tillings through another subsidiary in the same group.

A building material with a particularly interesting future is chipboard. There are some six or seven plants in the UK all installed since the end of the last war. Some of the chipboard



Graph A: New industrial building projects authorised by the Board of Trade.

Graphs B, C and D: Deliveries of civil engineering contractors' plant, monthly averages in £000.

(1) Figures based on first 6 months of 1960.

manufacturers started operations using German refugee labour in 1945 and several of them are equipped with German machinery. By 1959 the annual output of chipboard had risen steadily to 37,000 tons, and it is expected to have been double that level in 1960. There are now seven manufacturers and other interests are expected to instal plant in the near future so that there is scope for developing a chipboard plant industry. There is also scope for chipboard plant in export markets since under-developed countries are likely to want cheap building materials and chipboard being made mainly from timber waste, offers scope in this direction. The next few years may therefore see the further growth of the chipboard plant industry in this country with a useful export market.

Production

For the contracting industry as a whole the future of the road programme is of outstanding importance at the present time. Its abolute value can be easily exaggerated by the amount of publicity which the progress (or lack of progress) road development attracts. Nevertheless, the marginal significance of the road programme on the activity of manufacturers and hirers of excavating plant and manufacturers of building materials will be critical over the next year or two.

Figures published for the road building programme are exceedingly complicated and at times misleading. Maintenance work carried out by highway authorities exercises a big influence on contractors and makers of building materials. New roads, particularly new trunk roads, do not yet account for much more than half of the road programme. Table III sets out the comparative figures as estimated for the next few years.

TABLE III:—*Estimated Outlay on Roads by the Government and by Highway Authorities: £ million*

Fiscal years	New roads *	Maintenance
1959/60	77	82
1960/61	90	83
1961/62	108	85
1962/63	121	86
1965/66	160	—

* Including trunk roads and motorways.

Apart from increased expenditure on roads, however, there is another important and useful development in road policy. The Minister of Transport said last August that in future, highway authorities are to be told how much they can expect to get in grants in each of the three following years so that they should have a better basis for planning ahead. In a way this may be a counsel of perfection, because the Government must always reserve the right to curtail or extend the road programme in the interests of national economic policy. So far as the figures are concerned, whereas in the year 1959/60 the level of expenditure on roads was estimated to be £159 million, by 1962/63 it will be £207 million. Beyond that the figure for new roads will rise steeply again—economic policy permitting. From these figures it would appear that the complete road modernisation programme is going to be a 20 rather than a 10 year proposition.

Notable improvements in productivity have recently come about in the associated fields of quarrying and rock tunnelling. As an example of the former, Dorman Long have carried through a progressive mechanisation of their limestone quarry at Redmire in Wensleydale and trebled production since 1956. As much as 10,000 tons of limestone is now dislodged at one blasting and reduced to 6 in or less before dispatch to the works.

The best example of rock tunnelling in the country at the moment is to be found on the North of Scotland Hydro-electric Board's Loch Awe scheme where George Wimpey are driving a three mile long tunnel, 23 ft 6 in in finished (lined) diameter, through granite (see ENGNG., for last week, p. 00). Use is being made there of the Swedish technique of "ladder" drilling introduced to this country by Atlas Copco. The advantages gained with this method, combined with faster means of removing spoil, are leading to considerable reductions in costs.

Expansion and Investment

Though the new trunk roads will not account for much more than half of the total expenditure on roads over the next few years, they are likely to have a disproportionate effect on the technical and commercial outlook for both road-making equipment and building materials.

So far as road-making equipment is concerned, the new trunk road programme (as distinct from the annual maintenance programme on the roads undertaken by the highway authorities) will provide the opportunity for gaining experience in the logistics of using heavy excavating and road-making equipment. The building of the M1 has shown that there are big opportunities for the efficient mobilisation of heavy road-making equipment in a field of civil engineering where tendering is exceedingly competitive and costs per mile have to be reduced to the minimum. It is not likely, however, that the road-building programme, even if it is somewhat intensified over the next few years, will lead of itself to a big expansion in the demand for road-making equipment. There is still a surplus of excavating machinery left over from the curtailment of the open-cast coal excavation programme and there is a margin of concreting machinery available from the airfield expansion programme which came to an end some years ago. Asphalt-laying machinery is normally only about 50 per cent employed so that there is a certain margin available here as well. There seems little doubt that the road programme will create a problem of mobilisation of equipment rather than a shortage of machines over the country as a whole. (When John Laing and Son Limited built the M1 they used only about 30 per cent of their own equipment and the rest was hired.)

Much will depend on the phasing of the different trunk road schemes, and as time goes by the ordering of new roads might usefully take into account the need to get the optimum use out of available machinery and therefore spread the programme over a period of time so that road-making machinery can be efficiently mobilised and moved from one project to another. The worst outcome both for civil engineering contractors with their own road-making machinery and for plant-hire contractors would be for a large number of schemes to be started in a hurry so that all available machines were required on major schemes in different parts of the country at the same time. Some standardisation of carriageway width would also help to improve utilisation of the plant.

The arrival in this country of several large American concerns over the last few years has already imparted to the road-making and heavy excavating machinery industry a notable technical stimulus. The total value of contractors' plant and quarrying machinery delivered in the home market in 1959 was about £82 million. In 1960 it will have been between £90 million and £100 million. Over the next few years it is not likely that this level will be very substantially exceeded though it might increase slowly. There has also been a successful export drive that has reached an annual value of construction plant of £50 million. Some individual members of the Federation of Manufacturers of Construction Equipment are reported to be exporting 80 per cent of their output. (See Graphs B, C and D.)

Long Term Research

It is rarely appreciated what a vast amount of research is currently under way in civil engineering. Apart from the three establishments of the Department of Scientific and Industrial Research —the Road Research Laboratory, the Hydraulics Research Station and the Building Research Station—all the universities have engineering departments where some aspect of civil engineering is being investigated, and in addition there are such bodies as the British Welding Research Association and the Timber Development Association, both of which have major programmes in hand.

Some idea of the current scope of the work being undertaken is given by the list of topics currently sponsored by the Institution of Civil Engineers:

- Design of Arch Dams
- Piled Foundations, including work on deep-bored cylinder foundations, load carrying capacity of single piles and groups of piles, and ground movements below foundations
- Hydraulics of Sewage, including design of sedimentation tanks, effects of flow pattern on performance; syphons, regulation by air admission and their design for storm water relief
- Stresses and Deflections in Skew Bridges
- Behaviour of Structures under Service Conditions
- Ultimate Load Design of Concrete Structures
- Accelerated Testing of Concrete
- Deterioration in Sea-water of Timber and Reinforced Concrete (the 20th and Final Report of the Sea Action Committee appeared last year)

In addition to the work just listed, the Divisional Boards of the Institution have suggested the following topics for investigation:

- Methods of measuring compaction of black-top surfaces
- Skidding resistance
- Applications of mobile bed hydraulics to natural rivers
- Maximum flow velocities of sewers
- Behaviour of steel sheet piling in poor ground
- Treatment of asbestos sheeting to prevent mould growth in the tropics
- Use of aluminium for dock side structures
- Materials (other than timber) for the meeting faces of dock and lock gates

In the December 1960 issue of their *Proceedings*, the Institution announced that the Council are in the process of forming a Civil Engineering Research Council to sponsor and administer funds for research. At least £50,000 per annum are aimed at and generous contributions are expected from consulting engineers, contractors and the DSIR.

As has already been remarked, more fundamental work is required for the better estimation of run-off from catchment areas and even over the spillways of dams. To this end the Hydraulics Research Station are beginning a comprehensive investigation into the design of measuring flumes and weirs, including triangular and broad-crested forms with a variety of throat shapes.

Forecast

The prospect for 1961 for the civil engineering industry is bright in so far as it is concerned with heavy contracting but the two industries combined will have to face some slackening in the housing and general building fields—their largest outlets for work.

Overseas the potential is almost unlimited. Not that the work is there for the taking—either there may be no money to pay for the required work or, if there is, competition is severe, frequently being subsidised by governments interested in getting a footing, economically or politically, into the territory concerned. Problems, too, are different overseas. Servicing of plant can be exceptionally difficult, supplies for a contract other than the smallest can involve complex logistics and sub-contractors are the exception rather than the rule overseas. It is not an easy market anywhere, but there is plenty of work everywhere.

Electric Arc Melting on the Large Scale

GWB Furnaces Limited of Dudley have now received orders to build four large electric arc melting furnaces as part of Steel, Peech and Tozer's £10 million development programme. It was a year ago when GWB were awarded a contract to build two of these furnaces which will be almost twice as large as any previously built in Great Britain. The Dudley company has now received an extension to this first order.

The electrical demand of the four furnaces will be equivalent to that of a town the size of Wolverhampton. Each has an electrical rating of 40,000 kVA. Though they are to be entirely British built and engineered, the basic mechanical design is that of Demag-Elektrometallurgie. Nominal furnace capacity will be 150 tons, but they will be worked with a 110 ton charge in order to have a shallow bath with a large surface area. This technique is considered by some metallurgists to be a better way of making steel, rather than having a deep bath and smaller surface area for a given tonnage capacity.

The design of these very large furnaces is most interesting. The weight of the electrode supporting structure is permanently carried by the gantry which, after raising the roof, swings aside allowing charging of the furnace. Roof raising is by means of a hydraulic cylinder, the gantry being swung aside by an a.c. motor through a train of gears. The shell and gantry are mounted on a steel platform, the whole of which is supported by three arc shaped rockers which allow the furnace to tip forward through 45° for pouring and 15° backward for slagging. The drive for tilting the furnace is by two d.c. motors through gearing to pendant pin racks attached to the underside of the furnace. The control of tilting is through Ward Leonard sets.

The shell is arranged for rotation. This allows drilling of the scrap in three positions for each electrode—rotation being 40° either side of the normal electrode position. The ability to reposition the shell in respect of each of the three electrodes allows for more even wearing of the shell lining and so increases the tonnage output for each lining. Rotation of the shell is by means of an a.c. motor through gears.

The furnaces will be installed with interleaved heavy current connections from the transformer outgoing terminals to the point where the delta connection is made at the electrode clamps. Water cooled flexible cables are employed to carry the heavy phase currents from the transformer to the water cooled bus tubes carried by the electrode arms. To obtain maximum interleaving and balancing of electrode currents in each phase, four-electrode mast construction is employed. The two outer masts carry electrode arms which support the outer electrode, the arm movements being synchronised with each other. Balancing of the three electrode currents ensures even wearing of the shell refractory, greater stabilisation of the three arc currents and a reduction of the reactive power swing presented to the electricity supply system. The effect of interleaving the heavy current connection also reduces the percentage voltage reactance, so improving the power factor.

Single-acting ram-type cylinders are used for positioning the electrodes, and counter balancing is provided by arranging the exhaust from the cylinders to be at a positive pressure. The regulator employed for controlling the electrode position is of the true impedence type; a specially developed moving coil actuated valve being employed. The windings of this moving coil assembly have a high rate of response and high sensitivity and, as the hydraulic control valve is subject to oil pressure at each end of its operating piston, it will come to rest when the two pressures are equal. This arrangement eliminates any possible variation in calibration due to change in oil pressure or viscosity.

To ensure stable arc conditions, which are necessary to achieve the highest possible working power factor, electrical efficiency and minimum kWhr per ton to melt the steel, the mechanical construction of the furnace platform gantry and electrode supporting mast structure have been designed to enable the use of a high speed, high rate of response, hydraulic electrode control regulator. Interleaving the heavy current connections, and so reducing the reactance of this circuit, makes it essential to employ high speed electrode control in order to achieve a high working power factor during the breakdown period of the melt.

Power for each furnace will be derived from 40 MVA transformer specially designed for its duty and employing on-load resistor bridging type tap changing equipment. The transformer consists of two basic units, a tapped auto feeder and a double wound straight ratio unit. The heavy current terminations will be made by bringing out a number of parallel and interleaved connections for each of the three phases, connections being brought out from the windings through the side of the transformer tank. Transformers will employ forced oil cooling through an externally-mounted water-cooled heat exchanger. The primary winding will be suitable for connection to a 33,000 V, 3 phase, 50 cycle supply and the maximum arc voltage will be 565 V.

Separating Solids Suspended in a Liquid

In order to meet a demand in a variety of industries for a speedy and accurate method of separating or classifying solids suspended in a liquid, a new device known as the Hydrocyclone has been produced. It is a wet centrifuge in the form of a cylindro-conical vessel into which the liquid to be processed is injected under pressure.

The rapid rotating motion which is imparted to the liquid produces a very high centrifugal force, frequently of 15,000*g* or more, which forms two distinct vortices. The outer vortex carries the heavier solids to a nozzle in the apex of the instrument from which they are discharged together with some liquid. The lighter solids are entrained in the inner vortex to an axial overflow at the opposite end.

Owing to the very strong shearing forces also produced the Hydrocyclone is effective even with pulps of high solid concentration or plasticity.

Its ability to distinguish between granular particles and those which settle by means of flocculation or other form of aggregation, makes it particularly useful for cleaning such difficult materials as fibrous pulps.

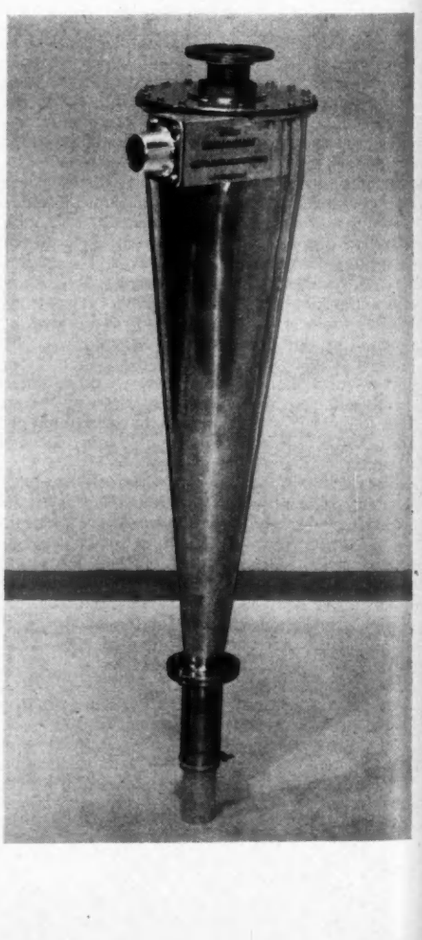
The Hydrocyclone is of simple construction and consists of a body, normally of cast aluminium or fabricated mild steel with a lining of special abrasion-resistant rubber. The upper part contains the vortex finder and overflow. An easily removable nozzle of solid rubber is fitted to the apex. To provide maximum protection against abrasion, which is intensified as the diameter lessens, the walls of the nozzle increase in thickness towards the orifice. In the smaller sized units the rubber body lining is replaceable.

Under normal conditions, the diameter (or size) of the Hydrocyclone selected for a particular application is dictated by the fineness of separation required, the smaller the diameter the finer the separation and this can be controlled by varying the diameter of the three orifices; the smaller the diameter of the feed inlet and of the overflow or vortex finder, the finer the separation achieved. The apex nozzle controls the proportion of feed volume rejected as underflow and consequently determines its solid concentration. The fineness of separation can also be increased by recycloning the overflow and the sharpness, that is to say, the efficiency of separation, by recycloning the underflow. Two other factors which affect the size of separation are pressure, the increase of which usually produces finer separation, and feed dilution. Some separations are, however, possible with pressure drops as low as 2 lb per sq. in, a difference often obtainable by gravity.

The Hydrocyclone is produced in models with capacities ranging from 4 to 1,200 gallons per minute. For fine separations at higher capacities, batteries of Hydrocyclones of 15 or 30 mm diameter can be installed. In suitable cases separations down to 5 microns are claimed to be possible.

This compact and efficient unit is being used extensively in laboratory research and among its many potential applications in various industries the following can be mentioned: degritting of cutting, grinding and honing fluids and of rolling mill cooling water, dewatering of slurry, desliming of sand as well as degassing, deflocculation and general classification and washing operations.

The instrument described is manufactured by Liquid-Solid Separations Limited, 2 Anderson Street, London, SW3.



The 300 mm diameter version of the Hydrocyclone which is used for the separation and classification of solids suspended in liquid.

Micro-Leak Detection

People troubled by very small leaks now have the opportunity of hiring equipment to detect and measure them. The service is provided by Vacuum Research (Cambridge) Limited, a subsidiary of the newly formed company, High Vacuum Engineering Limited. They offer the use of a helium mass spectrometer and a standard calibrated leak detector. As they point out, this method of micro-leak determination has hitherto been restricted to large laboratories associated with electronics research, chemical plant, or nuclear physics.

Possible uses of the equipment are for the detection and evaluation of very small leaks in pressure vessels, pipe lines, hermetically sealed containers, bellows, transistors, and vacuum vessels. The procedure consists of evacuating the system under test, connecting it to the mass spectrometer, and spraying the suspected areas with a fine jet of helium. Any helium entering a leak is drawn through the leak detector's vacuum system and indicates its presence on a galvanometer. Audible indication is also provided. A measure of the size of the leak can be obtained by comparing the galvanometer deflection with that produced by the standard calibrated leak detector.

It is also possible to pressurise systems with helium or a mixture of helium and another gas and to inspect the surface with a sampling probe connected to the vacuum system of the leak detector.

BCAC Revived

Representatives of the 32 organisations comprising the British Conference on Automation and Computation attended a luncheon given in London recently by Sir Walter Puckey, the chairman of the conference, to mark the reconstitution of the conference.

Speaking at the lunch, Sir Walter Puckey recalled that formerly the BCAC operated as a federation of three separate groups concerned respectively with the engineering application of automation, automatic control and computation, and the sociological and economic aspects of automation. He stressed that the recent merging of these groups in a single BCAC council in no way represented a contraction of interest; all three aspects continued to carry equal weight, and had balanced representation on the executive committee of BCAC.

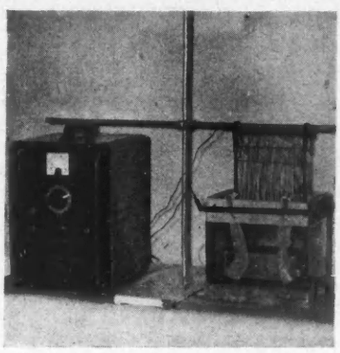
The purpose of the lunch was that the senior permanent officials of the member organisations should meet the chairman and the members of the executive committee. It also provided an opportunity for the chairman to outline and discuss with his guests the activities and developments which the executive committee had in mind.

Arrangements are now well advanced for the holding of a conference at Harrogate from 27 to 30 June, this year, with the general title "Automation—Men and Money." Its organisation is the responsibility of eight of BCAC's member organisations particularly interested in the social and economic aspects of automation. Plans are also in hand for the delivery of the first BCAC annual lecture in the autumn.

Ultrasonics and Gold Plating

For some time now, IDM Electronics Limited of Reading have been producing gold plated commutators and slip rings. The IDM process is carried out under licence for the Electro Tech Corporation of the USA and entails, essentially, the encapsulating of lead wires in a cylinder of plastic material which is cured and then machine grooved. One wire is locally exposed in each groove—all of which are then filled by a gold plating process and machined and polished to a surface finish of four micro-inches. Slip rings and commutators produced by this process have a number of advantages over those produced by other techniques. They have great mechanical strength, good wearing properties and they are little affected by changes of temperature and humidity. They are used in aircraft, radar, telemetering and general instrumentation applications.

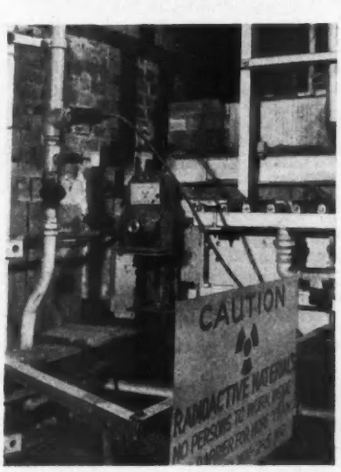
The plating operation is very complex and great care has to be taken to ensure homogeneity, especially when gold thicknesses above 0·015 in are used. An important and recent development in this process is the use of ultrasonic agitation to depolarise the electrodes. The IDM production line equipment consists now of a Dawe type 1152 2/0·5 kW generator powering four 1160/B36 immersible transducers in the plating tanks, although the accompanying illustration shows a smaller experimental set-up. Use of this equipment has helped to increase the homogeneity of plated rings and has greatly reduced the number of rejects.



Electrode depolarisation by ultrasonic agitation.

Improved Control for Bottle Making

The level of molten glass is being controlled within ± 0·01 in and feeder temperature within ± 0·1 per cent following the introduction of an automatic control system by Forster's Glass Company Limited of St. Helens to their furnaces and feeders. Equipment modernised in this way comprises four regenerative furnaces designed and made by Forster's themselves, two unit melters made by Emhart (UK) Limited, ten batch chargers, and 20 feeders.



A cobalt detector for maintaining the level of molten glass.

The close glass level control within 0·01 in applied to the molten glass in the forehearth is achieved with the aid of electronic circular scale controllers made by Honeywell Controls Limited, using radioactive cobalt isotopes for detecting the glass level. The cobalt unit emits a continuous signal which is fed to an amplifier made by Isotope Developments and thence to a controller. The latter is a continuous balance instrument of the potentiometer type. It automatically initiates control of a variable speed gearbox on the batch chargers.

The temperature control is applied to the channels and spouts of all feeders. It is achieved by means of Honeywell circular scale controllers using Radiamatic radiation pyrometers are used for temperature detection in the channels, and thermocouples for detecting the spout temperatures.

Control instruments for each furnace are panel mounted and the feeder control instruments are sited in cabinets disposed on the shop floor to suit machine and feeder layout.

This latest modernisation is part of a long term plant improvement programme at Forster's to give better quality and closer uniformity to their products.

Clean Conditions in Scotland

The installation of a £20,000 ultrasonic cleaning plant by Cockburns Limited of Cardonald, Glasgow, is important because it is thought to be the first of its kind in Scotland and the first in the UK to be operated by a valve manufacturer.

The company also has a clean conditioning room. This is an airtight structure of insulated steel panels with an air lock door. Clean, dust-free air filtered to 5 microns is supplied to the room by an air conditioning plant which main-an internal pressure of 2 in w.g. so that dust cannot enter. Because of Glasgow's atmospheric conditions, a special fog filter has been installed.

The new cleaning plant consists of a specially designed autoclave with a revolving carrier, solvent sprays, and transducers in the base for the introduction of ultrasonic power. The autoclave is within the clean conditioning room, and connected to a closed circuit solvent supply and drying system. This system, which is controlled pneumatically, embodies storage tanks for preheating and conditioning the perchlorethylene solvent, a filter battery pump and ring vacuum pump. For recovery of solvent, a distillation plant has been installed, comprising a still and a condensing unit. This equipment is situated outside the clean room.

Following the Motor industry

Telehoist Limited of Cheltenham, the hydraulic engineering member of the Wilmot Breeden Group, are to set up a new factory at Winsford in Cheshire. A 15 acre site has been acquired and initial production space of 40,000 sq. ft is planned by the company. The completed factory will be used for the assembly of gears and bodies made at Cheltenham.

The decision to build at Winsford was prompted by two main considerations: the need to free space now used at Cheltenham for assembly work to allow expansion of the manufacturing plant, and the decision of Vauxhall Motors Limited to switch their Bedford truck plant from Dunstable to Ellesmere Port on Merseyside. The new factory will be near to the projected Vauxhall site.

Telehoist are currently turning out some 400 steel truck bodies and hydraulic tipping gears a month at Cheltenham, where the production area has been more than doubled in the past four years to 130,000 sq. ft. The latest extension there, now nearing completion, has added 38,000 sq. ft to the factory in the past few months. Gears and bodies are being manufactured for vehicles from 3 to 22 tons.

Engine Measurements by Radio Telemetry

Dynamic measurement of the physical quantities of a high speed machine always presents a difficult problem. A technique using miniature radio transmitters is now being used.

CONSIDERABLE research and development effort has been put into the dynamic measurement of physical quantities in internal combustion engines over the years. Many techniques for the measurement of temperatures, pressures, stresses and strains of an engine's components under running conditions have been used. These normally make use of such devices as slip rings, flexible leads and intermittent contacts, which connect transducers on the moving engine parts to stationary metering equipment.

Needless to say, the use of any mechanical method of transmission between the internal parts of an engine and a stationary piece of metering equipment can lead to difficulty, tedium, inaccuracy and sometimes even complete failure of an experiment. Although physical data-transmission techniques have been used successfully on many occasions, there is no doubt that a technique involving no physical connection whatever between the moving parts and the meters would be highly desirable. Such a technique is now being used by the British Internal Combustion Engine Research Association, Slough, Bucks.

TRANSISTORISED

Research engineers at BICERA decided to investigate the possibility of a radio transmission technique with the advent of transistors, which are small and light enough to operate on high speed moving parts without affecting the conditions of the system that it meters. A miniaturised radio transmitter attached to the moving parts can send the transducer's signals to a transmitter aerial, from which they can be picked up by a receiver several feet away.

As a first exercise, BICERA engineers made equipment which would be suitable for transmitting the signals from strain gauges mounted on a rotating shaft. A block schematic diagram, showing the general electrical arrangement, is given in Fig. 1.

Each unit used in the transmission system comprises the necessary transducers and other electronic components encapsulated in an epoxy resin, which cures at room temperature with negligible shrinkage. This encapsulation protects the components from oil, moisture, dirt and mechanical damage. These units are attached to the shaft, together with the transmitting aerial, in the form of a loop around the shaft.

The technique has also been applied, in conjunction with temperature-sensitive elements, to the measurement of thermal transients and temperatures of pistons. An encapsulated transmitter, together with aerial and power pack, was mounted by BICERA engineers inside a 2½in diameter piston reciprocating in the cylinder of a sectioned engine.

Temperature indications were transmitted as the piston, with transducer mounted in its crown, moved first toward a heating element in the top of the cylinder and then towards a compressed-air jet at the bottom of the cylinder. This arrangement gave a curve, showing the variation of temperature with crank angle, on the screen of the oscilloscope. The transducer signal varied the carrier frequency directly, and at the receiver stage the frequency variations were converted into voltage variations suitable for display on the oscilloscope.

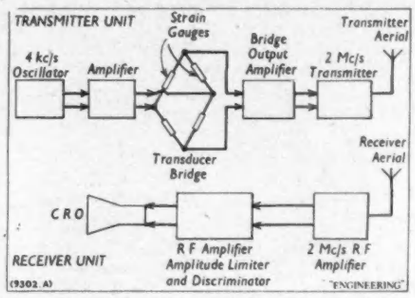


Fig. 1 A combined amplitude/frequency modulated system was used for strain gauge measurements on a rotating shaft.

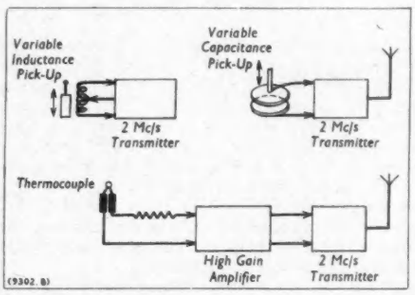


Fig. 2 By using various types of pick-up, a number of different physical quantities can be measured.

In another application, the telemetering technique was used to convey the signals from an injector needle movement pick-up, from an engine in a test cell to receiving equipment in an adjacent room. The needle-lift diagram which was obtained on the oscillograph was found to exactly match the diagrams recorded by conventional means.

TRANSMITTER TECHNIQUE

Early in the development work, a combined amplitude and frequency modulation system was considered in conjunction with strain gauge measurements on rotating shafts. This resulted in the system shown in Fig. 1.

A carrier signal of moderate frequency (4 Kc/s) is produced by an oscillator. This sinusoidal signal is passed through an amplifier to produce sufficient voltage to energise the transducer bridge, which consists of strain gauges. The 4 Kc/s carrier signal is modulated by the voltage due to the resistance changes of the strain gauge bridge. This amplitude modulated bridge output is passed to an amplifier and then used in a 2 Mc/s transmitter to produce frequency deviations of this 2 megacycle frequency, the deviation being proportional to the bridge voltage output. The resultant signal is passed to an aerial which radiates it to the aerial of the stationary receiver.

The low-level signal received is passed through two amplifier stages tuned to 2 Mc/s and any spurious amplitude modulation due to the moving aerial is removed by a limiter stage. The amplitude-limited signal is then fed into the frequency discriminator which converts the frequency excursions into corresponding voltage variations.

The resultant signal which is of the same form as the bridge output signal, is then displayed on the screen of an oscilloscope. If it is desired to remove the remaining 4 Kc/s carrier wave, this can be achieved by means of a low-pass filter. The choice of the transmitting system was based on several considerations. First, a carrier frequency was needed to enable static calibrations to be made. Secondly, the frequency modulation method applied to the transmitter required the feature of enabling any spurious amplitude modulations to be removed by the limiter stage in the receiver unit provided, of course, that the minimum amplitude of the transmitted signal is sufficiently large. Thirdly, the 2 Mc/s carrier frequency was chosen to permit the use of existing proprietary equipment operating at this frequency at the receiving end.

Fig. 2 shows examples of other uses to which the 2 Mc/s transmitter may be applied. The variable inductance element may be used in a needle-lift pick-up and the capacitance element in a pressure indicator. The thermocouple application would require a high resistance to obtain a voltage signal which is then passed to a high-gain amplifier before being used to vary the frequency of the 2 Mc/s transmitter. In all these systems, the transmitter equipment has fewer components than the strain gauge system of Fig. 1. The latter, however, could also be used for temperature indication by making one of the wire resistance gauges of tungsten which has a good temperature coefficient and a rapid temperature response.

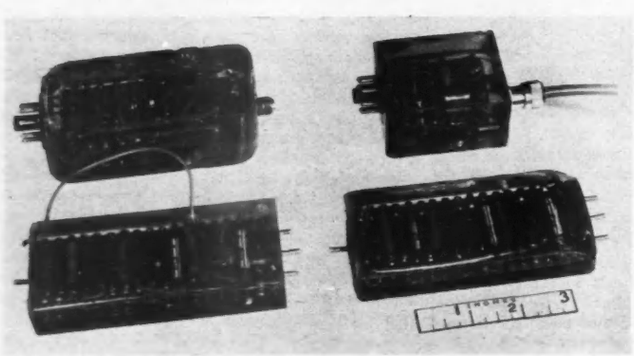


Fig. 3 (left) The electronic components are encapsulated in epoxy resin to keep them free from oil, dirt and mechanical shock.

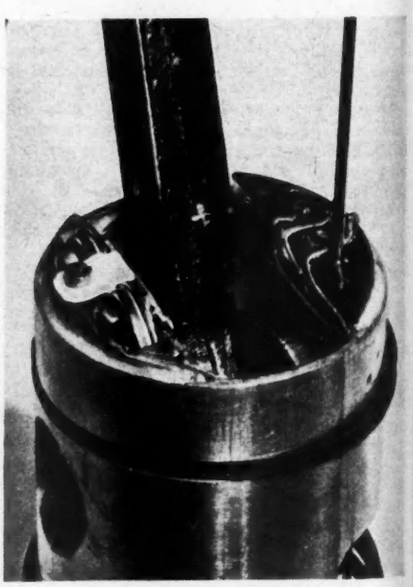


Fig. 4 (right) Piston temperature measurements were made by inserting a transmitter, with aerial and power pack, inside a 2½ in diameter piston.

Gauge for Ultra-High Vacuum

The production of ultra-low gas pressure is becoming of increasing importance in research. The achievement of pressures of the order of one billionth of an atmosphere are almost becoming commonplace in many physics laboratories. However, the problem of gauging such pressures still remains difficult. A new instrument for measuring and monitoring ultra-high vacuum has now been developed by research engineers at the Westinghouse research laboratories in the USA.

The new device, known as a photomultiplier ion gauge, was developed as part of an ultra-high vacuum research programme supported by the United States Atomic Energy Commission's "Project Sherwood." Project Sherwood is a long-range research programme aimed at obtaining controlled nuclear fusion, for non-military purposes. The new instrument is said to have many advantages over conventional low-pressure measuring apparatus for certain critical ultra-high vacuum experiments.

Instruments which measure extremely low gas pressures do so by placing electrical charges upon the gas particles remaining in a vacuum system, and then counting the rate at which these charged particles form. Conventionally, these charges come from particles that are thermionically released from a hot tungsten filament—similar to the filament of an ordinary electric light bulb—which is located inside the vacuum system. In many instances, the gas reacts with the hot surface of the filament, thus breaking the gas down and converting it to an entirely different substance. Thus the very act of measuring the gas pressure can contaminate the gas and upset the entire experiment. The new pressure measuring device overcomes these effects by eliminating the need for a hot filament. Instead of a hot surface, a beam of ultraviolet light is used to release electrons. The light is beamed on to a metal surface which has the ability to release electrons under the energy stimulus of ultraviolet radiation.

These electrons are guided by a series of similar surfaces which multiply the electrons in velocity and number. These electrons are then used to form the ions that are collected and counted in the usual fashion. The series of surfaces which releases the electrons and increases their number is called a photomultiplier, from which the name of the new measuring instrument is derived.

The photomultiplier gauge will be used in a series of ultra-high vacuum experiments, being ideally suited to low pressure studies of hot filament gas interactions such as those encountered in fluorescent lamps, thermionic vacuum valves and thermionic energy converters.

The gauge is linear with pressure over the range 10^{-3} to 10^{-10} mm of mercury. This range of pressures is equal to that encountered in space at distances between 60 and 650 miles above the earth's surface. In fact, the new device has already found application in pressure measurements and other experiments aimed at understanding the concentrations and interactions of the particles found in outer space through the laboratory simulation of outer space conditions.

New X-Ray Diffraction Laboratory

A new X-ray diffraction laboratory, to be used for research and student instruction, is a recent addition to the metallurgical engineering department of the Illinois Institute of Technology in the USA.

Used to determine the atomic structure of materials, the facility can serve as a means to forecast the strength and durability of various metals. Equipment of this type has also been utilised in uncovering the properties of materials and new methods to facilitate manufacture of intricate solid-state devices such as transistors.

The laboratory houses a micro-focus unit and four basic X-ray units, two diffractometers, a single crystal and a double crystal spectrometer, various single crystal and powder cameras, a liquid nitrogen cryostat and miscellaneous auxiliary equipment.

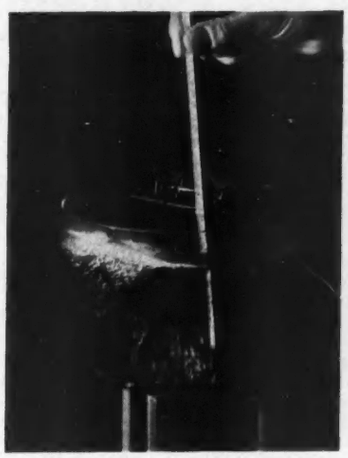
Research currently in progress in the laboratory includes crystal structure analysis, absorption-edge fine structure, alloy formation, crystal perfection, crystal growth and recrystallisation studies.

Activities in the new laboratory are under the direction of Dr. L. V. Azaroff, associate professor of metallurgical engineering.

High-Temperature Selenium Rectifiers

Selenium rectifiers have for many years been recognised as a reliable means of static rectification of alternating current. They are capable of handling overloads and excess voltage without serious damage and, unlike valves, they require no heater power.

By using the whole plate as an active rectifying area and by employing new vacuum deposition processes, the International Rectifier Company (GB) Limited, Oxted, Surrey, are able to produce selenium rectifiers with excellent high-temperature characteristics. No derating of current is needed for ambient temperatures of up to 45° C;



At 100° C, this selenium rectifier stack is able to deliver 30 per cent of its rated output.

and even at 100° C the rectifier stack shown in the illustration was able to deliver 30 per cent of its rated output.

Development and production facilities at the Oxted works of IRC are such that rectifier stacks can be built to almost any desired configuration. Their standard range of rectifiers is wide, with plate ratings from 200 mA to 13 A (half-wave ratings) and voltages of 26, 30, 33, and 36 volts per plate.

Extra-High Voltage Transmission

Extra-high-voltage power transmission reached what is believed to be its highest (voltage) level recently when the US General Electric Company placed about three-quarters of a million volts on a 4·3 mile experimental power transmission system.

"Project EHV" (extra high voltage) is an operation to assist American utilities to solve a number of problems in constructing future high-voltage transmission lines. According to Dr. P. A. Abetti, the project manager, "higher voltage is a sensible, economical way to help America's demands for twice as much power within the next ten years."

A 750,000 volt line will transmit over six times as much power as six 115,000 volt lines. They are expected to reduce the costs of construction, buying rights of way, towers, conductors and electrical apparatus. This would naturally help utilities to reduce their charges to consumers.

Transmission voltages in the United States now range from 115,000 to 345,000 volts. The Soviet Union's highest experimental power line is reported to be operating at 600,000 volts.

Twelve companies are contributing to the £2·7 million project, coordinated by General Electric's Power Transformer Department. An advisory council, composed of executives and engineers from 15 American and Canadian utilities, and a consulting engineers' committee with engineers from 14 US firms, are lending assistance.

The prototype system carries 267 instruments for the measurement of electrical, mechanical and radiological effects on the system. Checks will be made of the project's interference with radio and television. Other checks will be made on the effects of temperature changes, rain and wind, and humidity. Corona losses, known to be capable of reducing system efficiencies by as much as 50 per cent, will also be measured.

A data processing system will evaluate measurements at 20 minute intervals in good weather and at two minute intervals in bad weather. At the terminal building the data will be recorded on punched paper tape, converted to magnetic tape, and processed in an IBM 705 computer in order to provide the technical information in the correct form for analysis.

For test purposes, lightning will be attracted by 40 ft lightning rods on top of the transmission towers. An impulse generator will eventually be installed to discharge up to 3,000,000 volts to the line. Radioactive material will be buried in the ground directly underneath the EHV line to measure the earth's magnetic forces during spells of severe weather.

Improved Wear for Machine Parts

A thermo-chemical process, whereby simultaneous penetration of sulphur, carbon and nitrogen into the surfaces of steel and cast-iron machine components is ensured, has been developed by the Motor Transport Scientific Research Institute, Hungary. Surfaces treated with this technique are said to show a considerable improvement in wear resistance and sliding properties.

Employment of this process—sulpho-nitro cementing—greatly increases the working life and seizure safety of components which are subjected to frictional wear.

The field of application of the new process extends to all tempered steel or cast-iron machine components subjected to frictional wear (including gearwheels, shafts, pulleys, engine and compressor bushes, piston rings, valve guides, etc.) and certain components which are subject to erosion (e.g., turbine blades).

The process is said to increase the life of machine tool cutting edges. Furthermore, bronze bushes, worm wheels and other bronze parts can be replaced by components of sulpho-nitro processed cast iron.

Accurately controlled brake bench experiments with diesel engine cylinder liners and piston rings treated with the sulpho-nitro cementing process show that the working life of treated components can be increased by 30 per cent or more.

The working of cast-iron motor housings for pneumatic mine drills was increased by a factor of four after sulpho-nitro cementing treatment.

An advantage of this process is that it is applied to the component after it has been machined to size, without using toxic chemicals. No special equipment for heat treating is required for the introduction of the technique.

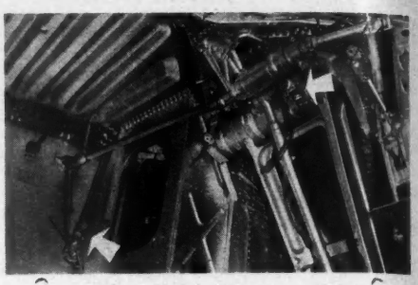
Hermic Switch Prevents Circuit Accidents

To provide increased operational safety in aircraft, Dowty Hermic switches are being used to prevent accidental functioning of certain circuits. Twenty-five of them are used in dH Comets, where to quote an instance they are employed in the nose and main-undercarriage lever lock system, which ensures that the undercarriage cannot be accidentally retracted when the aircraft is on the ground. A locking pin, which is the basis of the system, can only be withdrawn by an electrically operated solenoid which, in turn, is controlled by an undercarriage-actuated Hermic switch.

Other uses on the Comet include switches fitted to doors and hatches to prevent them being opened while the aircraft—which is of course pressurised—is in flight.

It is essential that the switches continue to operate irrespective of temperature or weather conditions and, as the name implies, the Hermic switch is hermetically sealed against all climatic conditions as well as being flameproof and waterproof. It has double-pole switch contacts with a simple make-and-break snap action, and the Mark 3 version can operate at altitudes up to 60,000 ft in temperatures ranging from −40° to 70° C.

Hermic switches prevent accidental functioning of certain circuits. The picture on the right shows two switches (arrowed) fitted to the Comet's main undercarriage.



Hermetic sealing is done by the use of glass/metal seals for protecting the terminal wires, while the switch operating movements are accommodated by metal bellows. The button mechanism, which provides ¼ in over-travel, is shrouded by synthetic rubber. In the switch itself, the terminals are housed in a mica-filled phenolic-resin block and are protected by a rubber grommet.

Switch action takes the form of a heavy-duty double-pole changeover contact arrangement. The moving contact blades are carried by a rocker and a soft iron armature which moves between two permanent magnets to provide the snap action. A feature of the design is that contact pressure increases up to the movement of changeover, thus reducing the tendency to arcing which is normally associated with low contact pressures at this point.

The switch is made by Dowty Electrics Limited, Tewkesbury, Gloucestershire.

Power Station Boilers Use Coal, Oil, or Refinery Sludge

Early in 1960 the Chief Minister of Bihar laid the foundation stone of the projected thermal power plant at Barauni. The equipment will be supplied by the Invest-Import of Yugoslavia and manufactured in close technical collaboration with some of the leading power plant fabricators of West Germany. It was designed by Kuljian Corporation of USA and India, the technical consultants to the State Electricity Board.

It will initially consist of two 15 MW turbine generator units. The plant has been designed on the unit system of a single boiler feeding the turbine. When a third 15 MW unit is installed in the near future and two more units of 50 MW each in the middle of the Third Plan period (1961-66), the cumulative capacity will have been raised to a normal rating of 145 MW. The first unit is scheduled for operation in the last quarter of 1961 and the second in early 1962.

The power station has been designed to work on pulverised coal which will come from the Jharia coalfields 300 miles A wagon tippler will facilitate quick unloading of the wagons. An automatic coal handling system of modern conveyor belt type will enable the coal to be carried right up to the boiler bunker straight from the unloading point. An oil firing system will start up the boilers. Oil will be obtained from the Barauni refinery directly into the buildings of the power station through a two-mile long pipe. The plant has been so designed that in future the boilers can be adapted to work on coal, oil or even on refinery sludge. Induced draught mechanical cooling towers will be used for the condenser cooling water.

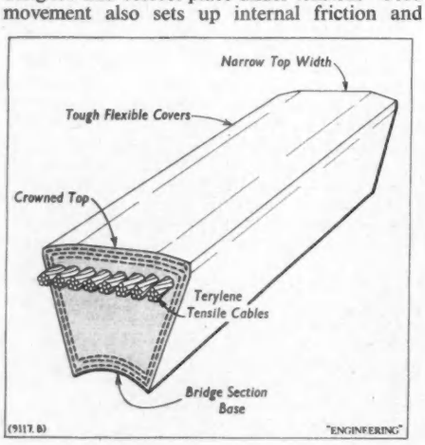
The steam generating units are each designed to generate 160,000 lb of steam per hour continuously. The operating capacity of the superheater outlet is 780 lb per sq. in at an optimum temperature of 840° F. The boilers have been designed for burning coal with a maximum ash content of 35 per cent. Provision has been made for the automatic handling of the boiler ash by hydraulic system. Steam will be supplied for each unit from a single boiler to a 15 MW air-cooled turbo generator having directly connected main and pilot exciters arranged along the length of the turbine hall.

A central mechanical control room will be provided for the remote automatic control of the boilers and turbines. The generator, transformers and the electrical equipment of other substations will all be remotely controlled from an electrical control room, separately located, in the operating floor. The floor will be laid between the present and the future turbo-generator units. As each generator, together with its associated equipment, constitutes a unit and is independent of the other units in the plant, every machine will be connected directly to its 20,000 kVA 11/33 kV transformer.

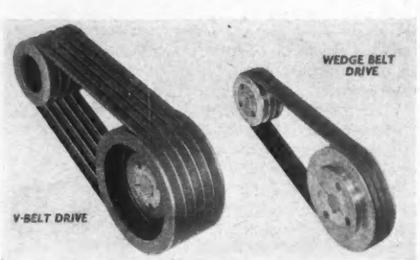
For the present, the station will transmit power at 33 kV, but in future when a 132 kV grid is installed in this part of India, the same transformer, by reconnecting the winding, will be able to step up the voltage to 132 kV. Each generating unit is provided with a 3,300V as well as a 400V busbars. These two-unit busbars will supply energy to all auxiliary equipment for their respective boilers and turbogenerator units. A separate 32/3 kV transformer will be provided to start up. It will also supply power to the essential auxiliaries of the power station.

Greater Loads in Less Space with Wedge-belt Drives

Many conventional V-belts fail because the load-carrying cords cannot be kept in their designed and correct place under tension. Cord movement also sets up internal friction and generates heat with detrimental effect on the belt. By introducing a wedge-belt with a concave base, J. H. Fenner and Company Limited, Marfleet Avenue, Hull, claim that this problem has largely been overcome because the shape of the base helps to keep the cords in their correct position.



SpacesaVer wedge-belts have narrower face widths and the makers claim that not only is pulley width reduced but greater loads can be transmitted.



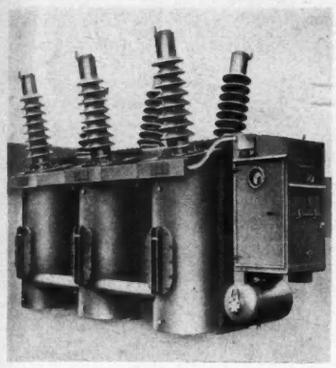
The belt—known as SpacesaVer—has a smaller cross-section than normal V-belts and one of the illustrations shows the corresponding reduction in width that is achieved. The use of Terylene cables bonded to the rubber insulation has given greater strength and flexibility. With higher belt loadings, the outer cover must be capable of holding the wedge-belt firmly anchored to the pulley, with no chance of oil or dirt penetrating to the cords within. It is claimed by the makers that the SpacesaVer range gives complete resistance to such enemies.

Because of the narrower grooves needed for the belts, the pulleys themselves have reduced face widths and a consequent saving in weight. The belts can flex around smaller pulley diameters and centre distances can be reduced. With specially designed high-grade castings, speeds of up to 6,000 ft per min can be specified, and drives are available up to 200 hp in two groove sizes to meet all except the largest requirements. Pulleys can be fitted with Taper-Lock bushes.

Oil Circuit-Breaker Easily Transported

Special regard for convenience of transporting and installation has been borne in mind in the design of a new 132 kV oil circuit-breaker.

Produced by the Switchgear Division of AEI Limited, Trafford Park, Manchester 17, the circuit-breaker—type LG6C—is of three-tank



Designed for shipment as a complete unit.

monobloc design and has 60 per cent less oil content than a conventional 132 kV oil circuit-breaker. It still retains all the required clearances under oil, and each phase is contained separately.

Rigid one-piece construction provides easy shipping and installation, the circuit-breaker being transported as a fully tested unit complete with mechanism and bushings. This construction ensures negligible deflection under short-circuit conditions.

A chance to prove the transport characteristics of the unit has been provided by the fact that AEI have already received orders from overseas.

Soaker Flanges in Two Pieces

Almost all manufacturers of roofing sheet produce standard soaker flanges with a corrugated base to match the sheeting profile. These are perfectly satisfactory for use with extractor ventilators where the exact position within an inch or two is not critical. With boiler flues and some other types of outlet, however, the position of the flue is fixed, and it is unlikely to coincide with the sheeting corrugations.

To make a special soaker means taking accurate measurements on site and is needlessly expensive. With a tall flue it is often difficult to thread the soaker over the top and when the flue is tall enough to need guy wires, impossible.

To overcome these difficulties, the Universal Asbestos Manufacturing Company Limited, Tolpits, Watford, Herts., have produced a two-piece soaker with a flat base and these are available to suit flues of up to 3 ft diameter. A flashing is required at its top edge, but it is divided horizontally so that it can be easily fitted around flues already in position.

"Do it Yourself" Computer Components

What are called " do it yourself " special purpose analogue computer components that will perform a variety of laboratory, engineering and process control computing tasks have been announced by Electronic Associates Limited, Victoria Road, Burgess Hill, Sussex.

The company claim that their TR-5 mounting unit makes it possible for special purpose analogue computers to be easily assembled without the problems usually associated with such a project. PACE solid state analogue computing components simply plug into the TR-5 mounting unit where they may be interconnected according to the computing function to be performed.

The TR-5 mounting unit contains all the controls necessary to operate a 20-amplifier computer. The basic unit will house up to six computing components and a fully-transistorised power supply. It may be expanded to large-computer capability by adding up to two expansion units to the basic rack.

One expansion unit, TR-5-1, is prewired to accept an additional five dual transistorised amplifier. Additional space is available but not wired, for five more dual modules or ten single modules for the addition of assorted linear or nonlinear computing components.

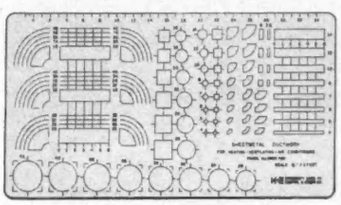
TR-5-2, the other expansion unit, provides space for ten dual or twenty single modules which can be wired to accept any PACE solid state analogue computing components.

The TR-5 is said to provide small to medium size computing capacity in a very small space, the actual requirement varying from 0·6 to 1·8 cu. ft.

Large Range of Draughtsman's Templates

Some draughtsmen prefer to work without the aid of templates but for those who get on with them there is a new range produced by Keuffel and Esser Company, Adams and Third Streets, Hoboken, New Jersey, US.

Consisting of 18 individual templates, they



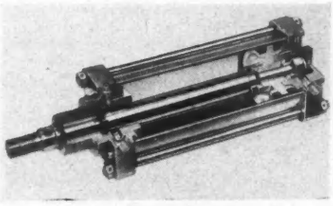
Template for sheetmetal ductwork.

are made of a high quality transparent plastic and are known as the " Speedraft " range. A wide variety of standard symbols, figures, and geometric shapes are available in graduated sizes and scales. Each aperture is precision cut and allowances have been made for pencil thickness.

Air Cylinders with Square Ends

Easily fitted interchangeable mountings can be applied to the range of square end air cylinders now being made by A. Schrader's Son, Division of Scovill Manufacturing Company, 829 Tyburn Road, Birmingham 24. In this way a basic cylinder can be used for neck, leg, front or rear trunnion, and in front or rear plate mountings.

The end plates are of forged brass and the tie rod assembly ensures perfect location with the heavy brass tubing. The tie rods also form the



Square ends give interchangability.

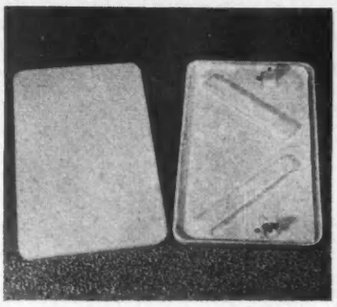
fixing points for all mountings attached to the end plates. Neck mounting threads are a standard feature of the basic cylinder and the hexagon mounting nut is supplied where this form of mounting is specified.

Another feature is that the cylinders can be supplied cushioned or non-cushioned. Many applications need a cushioned piston stroke to reduce impact shock without reducing the effective thrust force.

Operating pressures are from 5 to 150 lb per sq. in and four bore sizes are available from 1½ to 4 in. The ground steel piston rod is supplied in standard strokes of 4 to 12 in cushioned, and 1 to 12 in non-cushioned. Other stroke lengths can be specially supplied.

Lightweight Machine Access Doors

Instead of the usual heavy cast iron access doors which are normally fitted on machine tools, designers now have the option of specifying glass fibre reinforced polyester resin doors.



Designers have a choice of 33 sizes.

A range has been introduced by Lynester Products Limited, Nelson Lane, Warwick, and includes 33 sizes from 12 in square to 24 by 36 in. Increments are by 3 in, which means that any aperture can be covered by varying the size by 1½ in maximum each way.

The usual attributes of the material used apply with these doors, namely lightness, resistance to corrosion and strength. Of additional advantage on machine tools, resonance is cut down. No machining is necessary apart from drilling for the screw fixings.

Fittings for Overhead Power Lines

A new British Standard has been prepared to fill the need for standards of performance for various kinds of fittings used on overhead power lines in close association with the insulators and conductors.

The part now published gives general requirements and specific tests and the full title is: BS 3288: Part 1: 1960 " Specification for insulator and conductor fittings for overhead power lines: Performance and general requirements ". A second part, now in course of preparation, will be concerned with dimensional standardisation and will be confined to a limited range of fittings, based on present practice in the UK.

The mechanical requirements of the standard are related to the failing load of the fitting, which in effect is the highest reading that can be obtained on a testing machine regardless of the method of failure. In this way, difficulties resulting from differing views on permanent set, yield point and ultimate strength have been avoided. It is left to the user to decide on the relationship between the maximum working load and the specified minimum failing load, with due regard to all the circumstances and any relevant statutory regulations.

BSI say that they recognise that some of the tests are not established in commercial practice and so it may be necessary to review the specification after a shorter interval than would normally elapse.

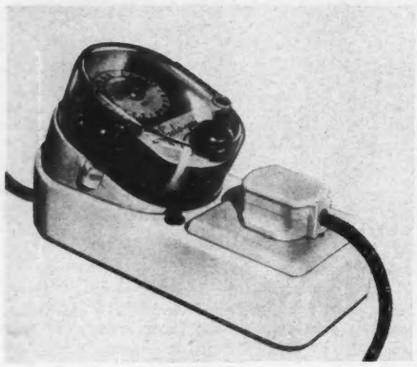
Copies of the standard can be obtained from: British Standards Institution, Sales Branch, 2, Park Street, London, W1.

Switches and Sockets

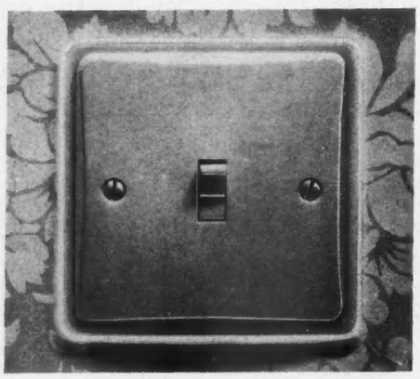
ALTHOUGH as a general rule long festoons of trailing flex are to be deplored, there must always be some portable electrical apparatus that will require a socket and a switch.

Not least among these will be the heater, whether of the radiant or convector type, so useful for warming a room quickly. For people who are out all day to come in to a cold room is not pleasant—an automatic switch is the obvious solution and one now on the market is rated for all electrical appliances. The Venner Autopoint will both switch on and switch off an appliance twice during each 24 hours. The minimum period between on and off is 30 minutes.

The unit includes a 13 A socket for plugging in the appliance and a lead for plugging into the mains socket. While the appliance is switched on a small red light glows on the unit. A manual control is incorporated so that the appliance can be switched on and off independently of the automatic control if desired. By correctly setting the hands it is possible to have only a single "on" period, the second pair remaining inoperative. Apart from heaters the unit can be used for lights, blankets or kettles, as well as for the radio, whether to give a warning alarm (for those who like to wake to music) or to ensure hearing a special programme. An interesting possibility is its use as a burglar deterrent. The sudden switching on of lights in an apparently empty house can be most disconcerting.



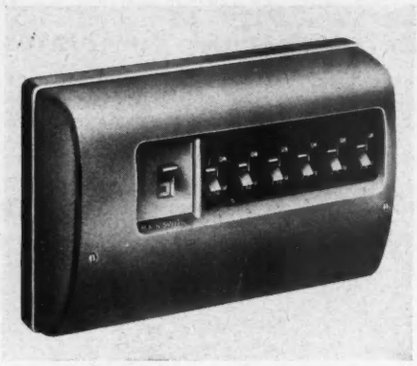
(Above) The Autopoint will switch an appliance on or off twice each day.



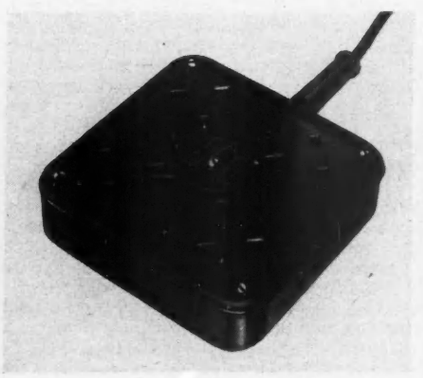
(Below) Using electroluminescence, the Locator panel outlines a switch in the dark.

The use of the ring wiring system with individually fused plugs has encouraged the abandonment of main fuses and their replacement by miniature circuit breakers. A recent example is that by Crabtree shown in the second illustration. This particular one has a mains switch rated at 60 A and six type C50 circuit breakers rated at 30 and 5 A. Other ratings for individual breakers range from 2·5 to 50 A. The breakers are set to trip at 30 per cent overload and have a built-in delay that prevents tripping due to transient faults. Various types of distribution panels which will take up to 12 ways are available and can have sealed covers if required.

The nuisance of trying to locate a switch or control in the dark has been overcome by the introduction of a luminous backing plate produced by MK Electric. Low voltage lights on bell pushes have been available for some time, but this is probably the first British panel using electroluminescence. Measuring 3¾ in square, the plate is designed to fit flush on the wall behind any flush-mounting accessory that has fixing screws set at 2⅜ in centres. In the dark it gives a luminous edging to the switch or socket, drawing its supply from the mains directly. In daylight it is ivory in colour. Two leads incorporating the necessary resistors are included, one being connected to the line and one to the neutral terminal of the mains. The consumption is barely measurable on normal meters and the life is indefinite. No replacements are required. The moulded frame that edges the Locator also prevents the surrounding decorations being soiled by greasy fingers. The low purchase price is an added attraction.



(Above) Miniature circuit-breakers are replacing mains fuses in ring circuits.



(Below) Multiple trailing leads can be reduced by a four-way 13 A socket.

A multiplicity of trailing leads can be reduced by the use of a multi-socket announced by the British Central Electrical Company. This is unbreakable, being moulded in rubber or neoprene, and the makers claim that it will withstand being run over by a lorry. The four 13 A outlets are fed from a single incoming cable that is fused at entry for a maximum total load of 13 A. The fuse is said to be easily replaceable. The incoming flex is locked by being looped completely round a central insulated post preventing it being pulled out or putting strain on the mains terminals. A similar four-way socket rated at 5 A is also available.

ENGINEERING

Published every Friday by Engineering Ltd. at 36 Bedford Street, London, WC2, England.
Telephone: Temple Bar 3663.
Telegrams: Engineering Lesquare London.

Chairman
J. A. Dixon, M.A., A.M.I.Mech.E.

Editor
F. B. Roberts, M.B.E., M.I.Mech.E.

Deputy Editors
D. Fisher, Ph.D., B.Sc., A.M.I.C.E., A.M.I.Mech.E.
E. P. Ward, M.A., A.M.I.Mech.E.

Department Editors
Atomic Review
D. d'A. R. Blackwall, B.Sc.
Book Reviews
E. P. Ward (Deputy Editor)
Construction
D. Fisher (Deputy Editor)
Design
J. T. Godfrey
Events in Advance
J. E. Dodsworth
Impact, Human Element, Companies, Marketing
J. D. F. Perry
Metals and Materials
D. C. E. Gribble, B.Sc.
New Plant and Equipment; At Home
A. A. H. Scott, B.Sc., A.M.I.Mech.E.
Product Profile
K. M. Brown
Production
J. R. Trotter, B.A.
Research and Development
R. A. Coffee, D.I.C., A.M.Brit.I.R.E.

EDITORIAL DESIGNER
G. T. Page, M.A.

SUBSCRIPTION MANAGER
G. A. Roberts

ADVERTISEMENT MANAGER
G. H. Dixon, M.A.

Contributed Articles
Notes for the guidance of contributors are available from the Editor. Contributed articles usually carry the author's name when published; they should be exclusive to ENGINEERING. When an article is accepted for publication the author is normally advised of the planned publication date.

Subscription Rates
One year, inland and abroad £5 10*s* (Canada, £5 5*s*). Three months 27*s* 6*d* all countries. Single copies 2*s* 7*d* post paid.

Back Numbers
Back numbers, from recent issues to certain of the earliest issues from 1866, are available at the usual price for single copies.

Reprints
Reprints of articles which have been published in ENGINEERING can be supplied. Requests for quotations, stating the quantity required, should be addressed to the Reprints Department.

Engineering Information Service
Assistance is available from Engineering Information Service in obtaining information, and in locating sources of information, both technical and commercial. EIS deals, for example, with names of makers and suppliers of plant and equipment, technical data on design, markets for engineering products, and the compilation of references to information on specific topics. Inquiries should be addressed to Engineering Information Service, 36 Bedford Street, London, WC2.

Advertisement Rates
The rates for advertising in the classified advertisement sections (Appointments, Company Meetings, Trade and Technical) are given in those sections. The Rate Card, covering all advertisements including display, is available from the Advertisement Manager.